SEP - - 1949

Sky and Telescope

In This Issue:

The New Asteroid with Smallest Known Mean Distance

Polarization of Starlight

American Astronomers Report

Telescopes for Juniors

Stars for September

★

Vol. VIII, No. 11
SEPTEMBER, 1949
Whole Number 95
25 cents

★

Palomar's 48-inch Schmidt camera

40-POWER ROSS STELLARSCOPE

Newtonian Type Astronomical Telescope

Complete, knocked down, ready to assemble in 15 minutes. All holes drilled, no additional parts necessary! All lenses completely ground and polished. Sharp, clear images. No color fringes, fuzz or distortion up to its theoretical limit of 150x. Light, portable (telescope 6 lbs., tripod 3 lbs.). Five years of intensive work on this type of telescope enables us to present the COMPLETE Ross Stellarscope — same principle as the Palomar and Mount Wilson instruments.

The 3-inch telescope mirror and diagonal are hard aluminized. Body of heavy full ¼"-thick compressed paperboard, beautifully finished — inside dull black, outside brown leatherette. Included are the most complete and simple instructions (pictorially illustrated) ever compiled for this type of telescope (instructions alone 50c). Every element is supplied, down to and including a screw driver. The Ross Stellarscope can be assembled in 15 to 30 minutes. Not a toy! This is a precision instrument for serious work on planets, moon, sun, variable stars, nebulae, and comets. The amateur will increase his knowledge of astronomy by actually seeing the heavenly wonders.

Stellarscope's standard 1¼" eyepiece fittings permit the addition of oculars for increased powers or accessories such as a solar eyepiece or a direct-view spectroscope.

All that is required to assemble the Ross Stellarscope is the small screw driver which we furnish. Nothing else to buy. Every lens and fitting of the Stellarscope is supplied ready for easy assembly by you.

Stellarscope hard wood lens fittings are made to last. We have concentrated on producing highest quality telescopes of finest definition. Every amateur astronomer should and can own one now!

(Knocked Down)

TELESCOPE complete (except for tripod) $15.50

TRIPOD 8.50

Total Cost $24.00

HARRY ROSS

TELESCOPES - MICROSCOPES

Scientific and Laboratory Apparatus

74 West Broadway, New York 7, N. Y.

Sky and TELESCOPE

Copyright, 1949, by

SKY PUBLISHING CORPORATION

CHARLES A. FEDERER, JR., *Editor*; HELEN S. FEDERER, *Managing Editor*

EDITORIAL ADVISORY BOARD: *Clement S. Brainin*, Amateur Astronomers Association, New York; *Edward A. Halbach*, Milwaukee Astronomical Society; *Donald H. Menzel*, Harvard College Observatory; *Paul W. Merrill*, Mount Wilson Observatory; *Charles H. Smiley*, Ladd Observatory; *Percy W. Witherell*, Bond Astronomical Club.

In Focus

THE WORLD'S largest patrol camera, 48 inches in aperture, is located on Palomar Mountain. Until recently, the 48-inch Schmidt telescope has seemed overshadowed by its 200-inch neighbor. However, the announcement of the new National Geographic Society-Palomar Observatory Sky Atlas has revealed the importance of this huge astronomical camera in conjunction with the program of the Hale reflector. Of great value in their own right, the 14-by-14-inch Schmidt plates will be used to select objects and regions upon which astronomers will turn the 200-inch eye for special study. By-products of the Schmidt survey should include the discovery of many new objects, such as novae, variable stars, comets, and asteroids. Of the last, a most unusual object has already been found, as described by Dr. Robert S. Richardson in this issue.

The front cover this month is a direct photograph of the 48-inch Schmidt instrument, with Dr. Edwin P. Hubble at the guiding eyepiece, while on our back cover is a drawing made in 1941 by the late Russell W. Porter to show the mechanical details and operation of this special camera.

In the lower left-hand corner of the back-cover drawing is a small sketch to show how the instrument appears in actual use. Compare this inset with the front-cover picture. The equatorial mounting is of the fork type, so that all parts of the sky may be photographed, and there are two guiding telescopes, each a 10-inch refractor with a focal length of 13 feet. Having two guiding telescopes enables the astronomer always to operate from the floor of the observatory, no matter to what portion of the sky the Schmidt is pointed. The massively built fork has closed ball bearings in its polar axis, and the tines of the fork are built with sufficient strength to minimize flexure differences. The moving parts weigh 12 tons.

At the bottom of the main tube is located the principal mirror, 72 inches in diameter with a radius of curvature of 240 inches, or 20 feet. Thus it equals in size the mirror of the Dominion Astrophysical Observatory at Victoria, B. C. Note the flotation system and edge support so necessary on large telescope mirrors to prevent flexure and strain from being introduced as the telescope is positioned to various areas of the sky.

To prevent vignetting, the correcting plate (a 53-inch piece of plate glass) with its aspheric surface is considerably smaller than the principal mirror, but even it is

(Continued on page 291)

VOL. VIII, NO. 11
WHOLE NUMBER 95

CONTENTS

SEPTEMBER, 1949

COVER: The 48-inch Schmidt telescope, with 72-inch primary mirror, at Palomar Observatory of the California Institute of Technology. At the eyepiece of one of the guiding telescopes is Dr. Edwin P. Hubble. A Porter drawing of this instrument is on the back cover this month. Mount Wilson and Palomar Observatories photograph.

THE NEW ASTEROID WITH SMALLEST KNOWN MEAN DISTANCE — Robert S. Richardson 271

POLARIZATION OF STARLIGHT — Otto Struve 274

AMERICAN ASTRONOMERS REPORT 279

TELESCOPES FOR JUNIORS — Frank A. Myers 282

Amateur Astronomers 281
Books and the Sky 286
Gleanings for ATM's 288
In Focus 270
Here and There with Amateurs 285
News Notes 278
Observer's Page 292
Planetarium Notes 281
Stars for September 295
Terminology Talks 277

BACK COVER: The 48-inch Schmidt telescope at Palomar Observatory, drawn by Russell W. Porter. Courtesy, California Institute of Technology. (See In Focus.)

SKY AND TELESCOPE is published monthly by Sky Publishing Corporation, Harvard College Observatory, Cambridge 38, Mass. Entered as second class matter, April 28, 1939, at the Post Office, Boston, Mass., under Act of March 3, 1879; accepted for mailing at the special rate of postage provided in Paragraph 4, Section 538, Postal Laws and Regulations.

Subscriptions: $3.00 per year in the United States and possessions, and to members of the armed services; Canada and all countries in the Pan-American Postal Union, $3.50; all other foreign countries, $4.00. Make checks and money orders payable to Sky Publishing Corporation. Canadian and foreign remittances should be made in United States currency. Circulation manager: Betty G. Dodd.

All notices of change of address must be sent three weeks in advance and accompanied by old and new addresses, or we cannot make the proper change. When sending your renewal order, or writing in regard to your subscription, your current mailing address must be given. For most efficient handling of your subscription, please return our bill form with your renewal payment.

Editorial and advertising offices: Harvard College Observatory, Cambridge 38, Mass. Unsolicited articles and pictures are welcome, but we cannot guarantee prompt editorial attention, nor are we responsible for the return of unsolicited manuscripts unless return postage is provided by the author.

A portion of the Palomar 48-inch Schmidt camera plate on which the new asteroid was found. It is enlarged eight times to show the streak made by the asteroid's rapid motion.

The New Asteroid with Smallest Known Mean Distance

By Robert S. Richardson

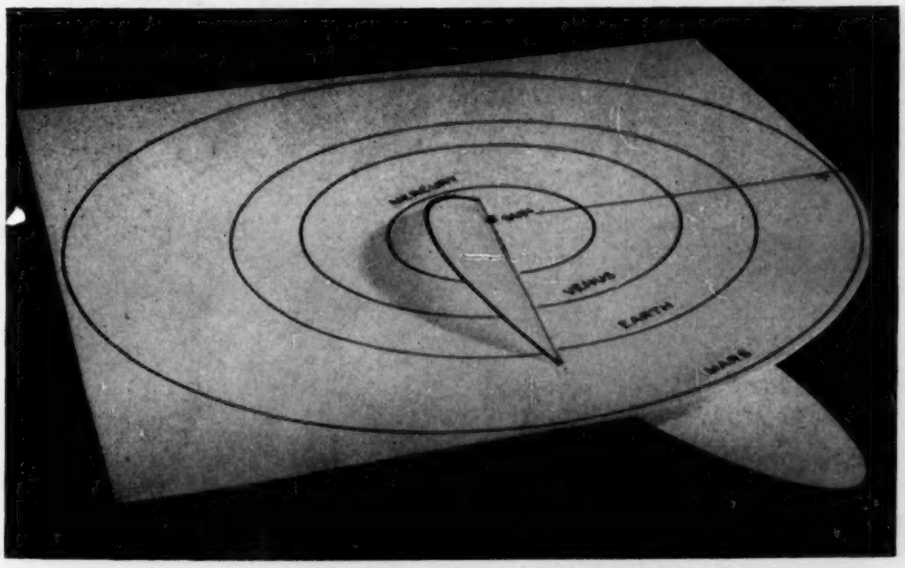
Mount Wilson and Palomar Observatories

IT IS HARD for us to realize today how much importance astronomers of a century ago attached to the discovery of an asteroid. When Gauss announced that Ceres was revolving at exactly the distance predicted by the Bode-Titius relation, the news created almost as much of a sensation as the discovery of Uranus 20 years earlier. We can judge what a prize each new asteroid must have been, when we remember that Hencke spent 15 years fruitlessly scanning the heavens before he found the fifth asteroid, Astraea. But then a century ago astronomy was regarded as practically an "exhausted" science.

At present there are more than 1,500 asteroids that have been officially named or given temporary designations. Keeping track of this swarm of little bodies requires so much laborious numerical computation that there seems no point in adding others to the list with orbital elements similar to hundreds already known. Thus, although astronomers often find asteroid trails upon their plates they seldom bother to measure them unless the motion appears unusual in some respect.

On the evening of June 26, 1949, Dr. Walter Baade had taken a 60-minute exposure near Antares with the new 48-inch Schmidt telescope on Palomar Mountain. Upon examining the plate next day he came across an asteroid trail so long that it would have covered a distance equal to the apparent angular diameter of the full moon in 11 hours. Motion as rapid as this indicated an object very close to the earth, perhaps another member of the Apollo-Adonis-Hermes group. It was so exceptional that he decided to secure the two additional observations needed to compute a preliminary orbit.

A single asteroid trail is like an arrow without a head — it shows the line of motion but tells nothing about its direction. In this case, the trail showed the asteroid was moving either southwest or northeast. It is a pretty good bet, however, that an asteroid picked up a few weeks past opposition is retrograding or moving west. Therefore, on June 28th Baade took his second exposure a little to the southwest of the first; and sure enough, the asteroid appeared at roughly the position expected from its rate of motion on June 26th. A third plate was taken on June 30th. The asteroid was then so near the sun and so far south that unless its path could be determined immediately it would certainly be lost as several other fast-moving objects had been lost before.



A photograph of a model showing the orbit of the new asteroid as related to the paths of the four inner planets. Photo by Kenneth Conant.

Now it so happened that Baade had planned to start his vacation within a few days, and was unable to do the work himself. The most hopeful prospects for the job were Dr. Seth B. Nicholson and myself. Nicholson, who had discovered Jupiter IX, X, and XI, still retained a keen interest in this field, while I had gained some experience in tracking down asteroids from assisting him in the past. I must confess that at the time the project did not appeal to me particularly. Whereas Baade was just at the beginning of his vacation, I was just at the end of mine, and in that exhausted condition when the very thought of work is depressing.

It might be supposed that determin-

Dr. Walter Baade, center, and Dr. Albert G. Wilson examining typical 48-inch Schmidt camera plates. Dr. Wilson is in charge of the Palomar Sky Atlas survey. Mount Wilson and Palomar Observatories photograph.

ing the position of the asteroid on the plates would be easy compared with computing its orbit. On the contrary, nearly a week went into determining the positions while the orbit was done in a couple of days. We ran into trouble right at the start when we found to our dismay that our library did not have the astrographic catalogue for zone −28°, corresponding to the declination of the asteroid, although the catalogues for zones −27° and −29° were available. Thus we were compelled to use comparison stars from these adjacent zones with the result that their distribution around the asteroid left something to be desired. Another minor difficulty was that the 14-by-14-inch Schmidt plates were too big for any of our measuring machines, and as we disliked to cut them, the measures had to be made from positive contact prints of the regions showing the asteroid.

Once suitable comparison stars were identified around the asteroid, it took only about an hour to measure a plate. Reducing these raw measures in millimeters to right ascension and declination is one of those elementary but tricky processes beset with pitfalls at every turn. For some reason, each observatory that participated in the *Carte du Ciel* program adopted a different method of reducing its co-ordinates, so that every time you use a new catalogue you have to learn a new method of reduction. Carrying through this procedure gives the position of an object for the equator and equinox of 1900.0, the epoch to which the stars in all the astrographic catalogues are referred. The final step consists in calculating the change produced by precession in the last 50 years to bring the positions up to date. We began work on the plates Tuesday, July 5th, and sent the three positions to the Harvard clearinghouse the following Saturday.

Nicholson already had computed an orbit for the asteroid, but as it failed to represent the positions of June 26th and 30th satisfactorily, a correction had to be made to secure better agreement with the observations. Most of the hot Sunday of July 10th was devoted to making this differential correction, as it is called. The work had become pretty exciting at this stage, for it began to look as if we had an exceptional type of asteroid within our grasp, and we were afraid it would slip away from us unless it was observed again as soon as the moon was out of the way. By Sunday evening we had derived corrections to the orbit that forced an agreement between the calculated and observed positions. Now we should be able to predict positions for the next two weeks with sufficient accuracy to keep the asteroid from being lost, at any rate.

Monday was spent in applying a few finishing touches to the differential correction and in computing the various constants of the orbit. Determining the six elements is always interesting, as these are the quantities that give you the first clear picture of the orbit in space. Upon reaching the formula for the semi-major axis I saw that it was going to come from taking the reciprocal of a number greater than one.

"Why, it's got a mean distance less than unity!" I exclaimed.

Nicholson glanced over my shoulder at the number the computing machine had just ground out — 95869. "Yes, Baade picked up a really good one this time," he said.

Although it now appears that the mean distance slightly exceeds one astronomical unit, to me this is still the big moment of the investigation.

We had hoped to have an ephemeris of predicted positions completed in time to give to Bruce Rule before he left for Palomar Tuesday morning, but as is usually the case the computations took longer than we anticipated. Tuesday afternoon we telephoned our predicted positions to Rule at the observatory, who promised to do the best he could for us although the moon was still uncomfortably close to the region desired.

In the meantime, a rather disquieting letter had arrived from Dr. Leland E. Cunningham at the Students' Observatory in Berkeley. He remarked that the observations could be represented almost equally well by half a dozen orbits with values of the mean distance ranging from around 0.90 to infinity! He also included three ephemerides which showed how small an effect the wide range in solution had upon the predicted positions. It thus appeared as if the preliminary orbit might be so indeterminate as to be of scant value if it had to be used as the basis for predictions far in the future. The question could not be resolved until more observations became available.

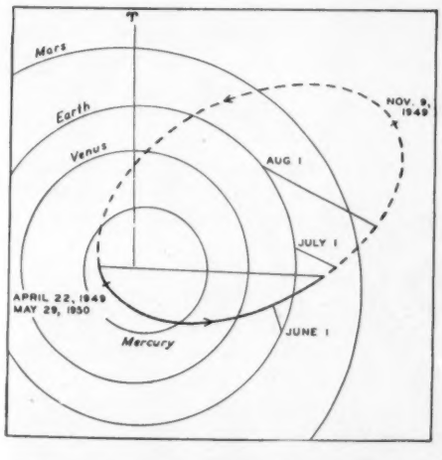
Rule was able to photograph the region occupied by the asteroid on July 12th and 13th; and knowing our anxiety to see the plates, he went to the trouble of bringing them over on Friday, July 15th, directly upon his returning to Pasadena. Finding the asteroid on these plates was quite a different proposition from before. The asteroid when discovered was approaching its stationary point, but still appearing to move fast enough to leave a long trail easily recognizable at a glance. But now the asteroid had slowed down to such an extent that its trail would be hard to distinguish from the multitude of star images surrounding it. After a brief period of uncertainty when it began to look as if the asteroid might have to be detected by the tedious process of blinking the plates on the comparator, a suspicious-looking elongated image was spotted near the predicted place. Identification became positive when a similar image was found shifted by about the right amount among the stars on the other plate.

The two positions of July 12th and

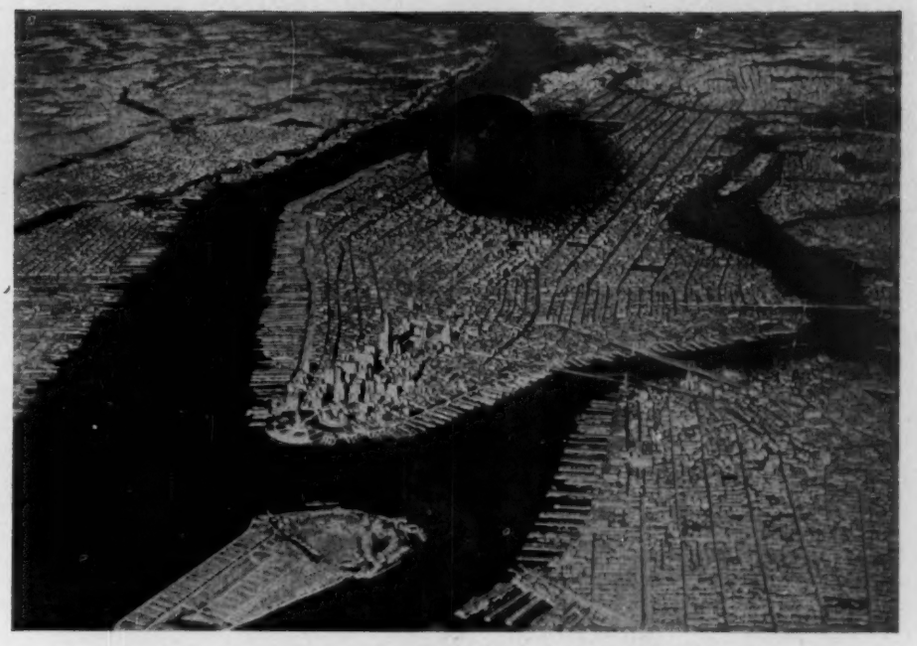
13th enabled the true character of the orbit to be fixed without much further doubt. The mean distance barely exceeds one astronomical unit, which is much smaller than that of any known asteroid or comet. At perihelion the asteroid passes inside the orbit of Mercury to within 21 million miles of the sun; while at aphelion it recedes beyond the orbit of Mars to a distance of 177 million miles. The closest approach of the orbit of the asteroid to the orbit of the earth occurs near the descending node, at a distance of about 4,600,000 miles. About June 21, 1949, both the asteroid and the earth were near this point and within about eight million miles of each other. The closest that any celestial body has been known to approach the earth except the moon and meteorites is the asteroid Hermes, which on October 30.5, 1937, came within 485,000 miles.

The magnitude of the new asteroid on June 27th, at a distance of 22 million miles, was estimated by Baade as 16. At the minimum distance of 0.05 A.U. the magnitude would be 12.5. The diameter inferred from the apparent brightness is 0.9 miles, or about 4,800 feet.

It is of interest to gain some notion of the range in temperature that this tiny body undergoes in its trip around the sun. At its perihelion distance the maximum temperature of a non-rotating airless black planet would be 800° K. or 1,000° F. This may be compared with the temperature of 685° K. at the subsolar point of Mercury measured by Nicholson and Pettit. The limiting temperature for visibility is about 700° K. It is possible that near perihelion the surface of the asteroid exposed directly to the sun may be hot enough to glow a dull red. But the temperature may be considerably below this figure if the object is rotating rapidly and its surface far from black. Six months later, at aphelion, the temperature must be below freezing.



The orbit of Baade's object. No account has been taken of the differences in orbital planes, but that part of the new asteroid's orbit below (south of) the ecliptic plane is shown dashed. Perihelion passage times are given. Note the position of close approach to the earth's orbit near the descending node. Compare this chart with the model photograph on page 271.



The new asteroid (not necessarily spherical) is perhaps larger than this sphere, which represents ¾ of a mile on a model of New York City. This photograph, by the American Museum of Natural History, was made to represent Hermes, the asteroid that approached within 485,000 miles of the earth in 1937.

The eccentricity of the orbit is so high as to raise the question of whether the object is a comet instead of an asteroid. No trace of coma could be discerned on the photographs when the body was distant about one astronomical unit from the sun. If a coma develops at smaller heliocentric distances it would be extremely hard to observe. It would seem that all volatile material should have been driven away long ago by close approaches to the sun at such frequent intervals.

Until relatively recently it was believed that all the known asteroids were confined to zones between the orbits of Mars and Jupiter, and this fact has played an important part in theories of the origin of the planets. But the discovery of objects such as this one, together with others, notably Amor, Apollo, Adonis, and Hermes, indicates that asteroids exist much closer to the sun than was previously supposed. Hence, the search for fast-moving objects may eventually prove of value in connection with the ever-fascinating problem of the evolution of the solar system.

In 1924 Baade discovered asteroid Hidalgo, which at aphelion recedes to a distance of 9.6 astronomical units, out to the orbit of Saturn, the farthest of any known asteroid. Twenty-five years later, with the 48-inch Schmidt telescope, he has the distinction of discovering the asteroid with the smallest perihelion distance, and the first body aside from comets and meteors to pass within the orbit of Mercury.

As already mentioned, the general character of the orbit of Baade's new object now is fairly well settled. Only one big problem still awaits solution — *What shall we name it?* Astronomers are wide open for suggestions.

The approximate elements below have been obtained by interpolation from the first and second orbits given by Cunningham on Harvard Announcement Card 1012.

ELEMENTS (1950.0)

Angle to perihelion	31°.32
Longitude of ascending node	87°.75
Inclination to the ecliptic	21°.23
Semimajor axis (astron. units)	1.066
Eccentricity	0.789
Time of perihelion	April 22, 1949
Period of revolution	402 days

BAADE'S OBJECT

Harvard Announcement Card 1017 reports the following positions of Baade's object, from photographs by Dr. Baade and measures by Drs. Nicholson and Richardson:

1949 UT	α (1950.0) h m s	δ (1950.0) ° ′ ″
July 23.19583	16 00 01.70	−29 47 23.4
July 24.18750	16 00 06.74	−29 49 16.5
July 28.20633	16 00 59.85	−29 56 51.0
July 28.22369	16 01 00.01	−29 56 52.4

The first two positions were obtained with the 48-inch Schmidt and the last two with the 100-inch reflector on Mount Wilson. From a comparison with Standard Area 57, Baade finds the magnitude on July 23rd to be 18.8.

Polarization of Starlight

By Otto Struve, *Yerkes and McDonald Observatories*

THE YEAR 1949 will undoubtedly be recorded in the annals of science as that in which one of the most important astrophysical discoveries was announced. In the February 18th issue of *Science,* W. A. Hiltner and John S. Hall independently presented their observations of a new property of light from distant stars — its polarization by the action of small interstellar particles.

The effects of polarization are easily observed in the laboratory. In Fig. 1 an ordinary beam of sunlight is reflected at 55° from an unsilvered piece of plane-parallel glass. This reflected beam is thrown upon another, similar piece of glass (A_1), also at 55°. If we now turn the second piece around an axis which coincides with the direction of the incoming once-reflected beam, we shall detect a slight periodic variation in the intensity of the light. No such change is found if we have only one reflection. This experiment demonstrates that the once-reflected beam possesses a property that was not present in the original beam from the sun: it is partly plane-polarized.

Most natural sources of light are unpolarized, and a piece of polaroid filter transmitting such light produces no change when it is rotated. But reflected or scattered light is often polarized. This phenomenon finds a simple explanation in the electromagnetic theory of light, according to which the observed properties of light can be almost completely explained by assuming that it consists of vibrations, at right angles to the direction of propagation, of certain mathematical concepts described as the electric and magnetic vectors (Fig. 2). In ordinary, unpolarized light the vectors are distributed at random around the direction of propagation. An unsilvered glass plate or a polaroid filter sorts out those vibrations, and components of vibrations, which are all in one plane. Light made thus inhomogeneous can pass freely through another polaroid filter oriented the same way as the first. But it is completely extinguished if the second polaroid is turned 90°.

In astronomy the phenomenon of polarization has been studied by Lyot, and others, in connection with the reflected light of the planets, and by a host of observers in connection with the solar corona. But in stellar astronomy it has previously played an insignificant role. The light of reflection nebulae has been known for a long time to be polarized in such a way that when the principal axis of a polaroid filter is placed at right angles to the line joining a nebula and its illuminating star, the surface brightness is appreciably smaller than when the polaroid is turned 90° from this direction. This type of polarization is produced by small particles, in accordance with the laws of scattering, and is often designated as radial polarization. It is present in the nebulosities surrounding Rho Ophiuchi, in the Pleiades, and in NGC 7023. In the last, L. G. Henyey found a maximum degree of polarization of 12 per cent:

$$p = \frac{I_A - I_B}{I_A + I_B} = 12\%,$$

where I_A and I_B are the maximum and minimum intensities of the light observed as the polaroid is turned. For the reflection nebula NGC 6729, W. T. Whitney and E. B. Weston found values up to $p = 35\%$. This type of polarization is well known in the case of the daylight sky, where it can be easily detected with a pair of polaroid glasses.

But the transmitted light of a star passing through a cloud of small particles is not necessarily polarized. For example, the light of the sun, passing through our atmosphere, is weakened by the absorption of the molecules of air in such a manner that it remains unpolarized. This is due to the symmetry of the scattering process. Even though the scattered light observed from a direction at right angles to the propagation of the beam may be strongly polarized, the plane of polarization would rotate if we observed the medium from all possible directions. Hence, if we could combine the light scattered in all directions and observe it at once, we would find it to be unpolarized. The remainder of the light in the original beam is, therefore, also unpolarized.

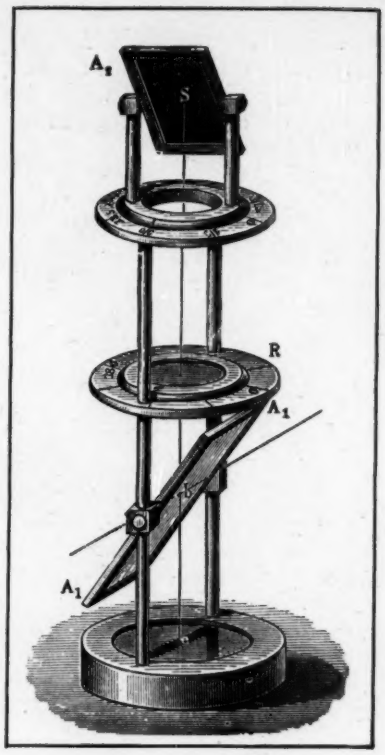


Fig. 1. A device for detecting polarization of a beam of light which is incident upon the unsilvered glass plate A_2. The reflected beam passes vertically downward and falls upon the plate A_1. If the latter is turned around the vertical axis by means of the ring R without changing the orientation of A_2, the intensity of the light is found to vary.

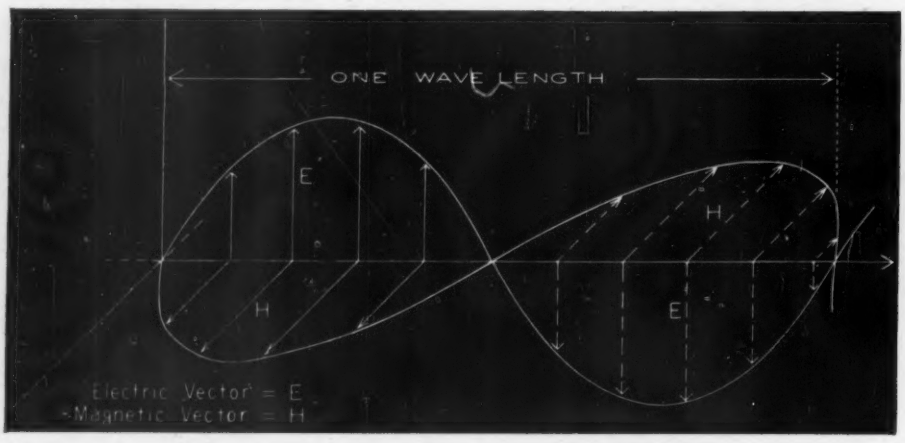


Fig. 2. A concept of the components of a wave of electromagnetic radiation. The electric and magnetic vectors are at right angles to each other.

Fig. 3 shows at the top two photographs of an electric light bulb placed inside a rectangular glass tank filled with a colloidal solution of rosin in water. The spot of light (shown black in the negative) appears on the right to have a greater horizontal extension, and has a greater vertical extension on the left. This was caused by a polaroid filter in front of the camera which was turned 90° between the exposures. Similarly, the nebula NGC 7023, below, has a greater extent horizontally when the axis of the filter is placed vertically. This is a typical example of radial polarization in a diffuse medium.

Although a few experiments were

made by Oehman and others many years ago, to test the light of ordinary stars for polarization, the results were not conclusive. A revival of interest in this problem arose when S. Chandrasekhar predicted in 1946 a small amount of radial polarization near the limbs of early-type stars, caused by the presence of large numbers of free electrons in their atmospheres. The symmetry of the polarization renders this effect unobservable when the light of the entire star is integrated by the photometer. But in an eclipsing binary, just before totality sets in, a small crescent of the eclipsed star remains visible, and its light should be plane-polarized. In June, 1946, Edith M. Janssen made some promising photographic observations of U Sagittae with the 40-inch telescope of the Yerkes Observatory; and a few months later Hiltner obtained fairly convincing evidence that a small amount of polarization is present at the limb of the brighter component of RY Persei, and that the plane of its orbit has a position angle of about 152°.

Because of the exceptional importance of this problem (to which repeated attention had also been called by Z. Kopal) Hiltner, in collaboration with Hall, then of Amherst College, undertook in August, 1947, a series of observations with a photoelectric photometer attached to the 82-inch reflector of the McDonald Observatory. They selected the Wolf-Rayet eclipsing binary CQ Cephei, HD 214419, which Hiltner had previously observed spectrographically and photometrically. In a report to the American Philosophical Society for 1947, Hiltner stated that "evidence was obtained for the presence of polarization of radiation from the limb . . . ," but the instrument was not reliable and both observers agreed to rebuild the apparatus in order to eliminate the instrumental errors which had made it difficult to discern the true effect. In subsequent months Hall, with considerable help from Hiltner, perfected his own polarizing photometer. During the summer of 1948 Hall was prevented from resuming the work at McDonald (because of his transfer to the U. S. Naval Observatory) and Hiltner observed alone, with an instrument of his own construction. This time he found unmistakable evidence of polarization in CQ Cephei and a few other, very distant, stars, but not in several nearby comparison stars. Repeated observations on different nights showed that the polarization of each star remains constant. We can glimpse something of the excitement which accompanied this work from the frequent exchanges of information, sometimes by long-distance telephone, between Yerkes-McDonald and Amherst-Washington. Hall also observed definite polarization in CQ Cephei, but there was at first no complete agreement as to its amount.

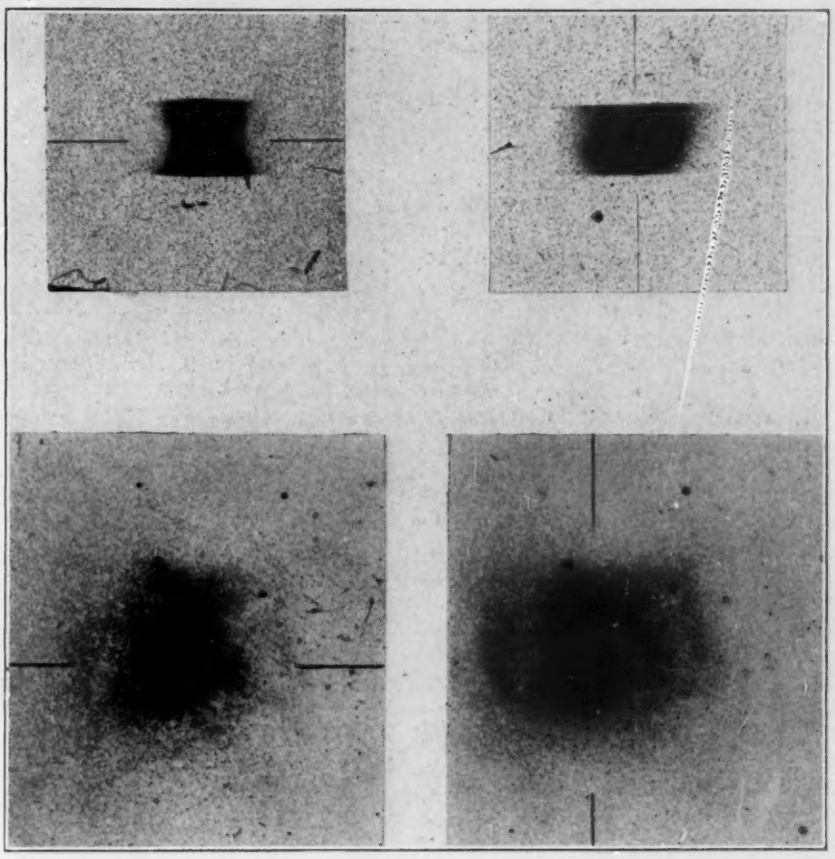


Fig. 3. At the top are two photographs of light diffused in a colloidal medium from a light bulb kept near the center of the liquid. A polaroid filter was used in front of the objective. At the bottom are two photographs of a reflection nebula (NGC 7023) taken through polaroid filters in two orientations. On the left side the nebula has a slightly elongated shape with the vertical axis longer than the horizontal axis. On the right side the horizontal axis is the longer. This shows an effect of polarization similar to that observed in the colloidal medium, but smaller in amount. Engraving, courtesy "Astrophysical Journal."

It became evident that the polarization did not depend upon the phase of the eclipsing binary. This was at variance with Chandrasekhar's prediction. In a dramatic session of the Midwestern neighborhood group of astronomers at Yerkes Observatory in the early fall of 1948, Hiltner presented his results in such a way that the whole audience could see that he had observed a new phenomenon. Chandrasekhar commented upon it in the following words:

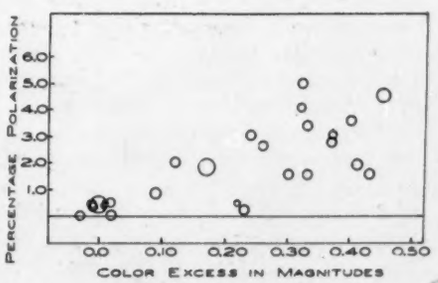


Fig. 4. The correlation observed by John S. Hall between color excess and percentage of polarization for early-type stars. The color excess values are from Stebbins and Huffer. The size of each circle indicates the weight of the observations. From a diagram in "Science."

"An entirely new tool has been discovered for astrophysical research and the indications are that Hiltner is correct in attributing the polarization to the action of interstellar particles." But it was still possible that instrumental effects distorted the observations.

In November, 1948, Hiltner made a trip to the Lick Observatory, and there G. E. Kron verified the polarization with his own photoelectric photometer. Immediately afterwards Hiltner secured additional results at McDonald. The degree of polarization was found to increase with the distances of the stars, and it could be observed in single stars as easily as in binaries. There is a rough correlation between polarization and interstellar reddening which was also found by Hall (Fig. 4). But Hiltner has concluded that in the Double Cluster of Perseus where, according to Morgan and others, the interstellar reddening changes rapidly with galactic latitude from almost zero to 0.5 magnitude on the scale of Stebbins, Huffer and Whitford, the correlation with polarization is weak. Furthermore, the two stars BD +31°642 and +31°643, which are approximately at the same distance of 200 parsecs but have color

excesses of 0.1 and 0.4 magnitude, respectively, give almost no polarization. Hiltner concludes that the existence of a large color excess is a necessary but not a sufficient condition for the presence of polarization, so that, presumably, in addition to a dense medium there must be some special property, not always realized in nature, such as uniform orientation of the interstellar grains, before the light becomes polarized.

Hiltner noticed that the plane of polarization seems to have a tendency to be parallel for stars located close together in the sky. This is particularly well shown by the members of the cluster in Perseus, where the position angle varies between the narrow limits of 109° and 121°. There is a general tendency for stars which lie close to the Milky Way to show polarization with the maximum electric vector approximately parallel to the galactic plane. However, there are many exceptions, as was shown by Hall (Fig. 5), who plotted the orientations against galactic longitude. It should be noted that the planes of polarization as defined by Hall differ by 90° from those of Hiltner. There is, thus, close agreement between the two sets of data. At first it was believed that there was also a difference by a factor of 2 in the numerical amounts obtained by the two observers, but there was really no discrepancy. Hall used the ordinary definition of polarization, while Hiltner used the definition: $p = 2(I_A - I_B)/(I_A + I_B)$, found convenient in Chandrasekhar's theoretical treatment, which is twice as large as Hall's quantity.

It is now certain that the interstellar dust somehow produces an unsymmetrical weakening of the transmitted light from the stars. Hiltner believes that the effect must be caused by magnetic fields in interstellar space. Through a remarkable coincidence, E. Fermi had just announced his theory of the origin of cosmic rays when Hiltner's and Hall's results were published last February. Fermi had assumed that magnetic fields are present in interstellar space, and the polarization observations provided an immediate confirmation.

The theory of the polarization effect is only in its beginning stages. L. Spitzer, Jr., and J. W. Tukey have recently shown that ferromagnetic particles can account for the observations if they have the shape of needles. Interstellar grains often collide, and the more volatile constituents, such as water vapor, ammonia, methane, and so on, are rapidly evaporated as the result of the heating action produced in the collisions. This leaves needle-like pieces of iron compounds, such as Fe_3O_4, which are ferromagnetic and therefore sensitive to the magnetic fields postulated by Fermi. In a more recent paper, L. Davis, Jr., and J. L. Greenstein have independently treated the question of scattering by

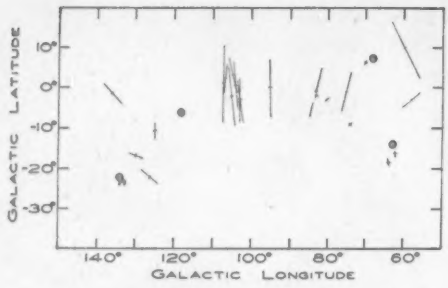


Fig. 5. The relation between the plane of polarization and location in the galaxy, by John S. Hall. Stars showing no polarization are represented by circles. From a diagram in "Science."

elongated particles which are oriented parallel to one another by a general magnetic field whose lines of force are perpendicular to the galactic plane. It has been known since 1912, from the work of R. Gans, that elongated particles oriented in a preferential direction must scatter different amounts of light, depending upon whether the vibration is parallel or perpendicular to the long axis of the particles. As to order of magnitude, the observations are in accord with the theory.

At the Ottawa meeting of the American Astronomical Society this June, Hall and A. Mikesell presented their latest observational results. The largest amount of polarization on their scale was seven per cent. On Hiltner's scale it would have been 14 per cent. The very distant supergiant 55 Cygni has a polarization of three per cent. A few stars at high galactic latitudes were also found to have appreciable polarization.

It is perhaps regrettable that Hiltner and Hall did not combine their results but published them separately. Apparently their joint observation in August, 1947, was somewhat more convincing to Hall than to Hiltner. But in their subsequent independent observations they have in a most remarkable way extended their earlier work and reached substantially the same conclusions. The question of priority, which may seem important at the present time, will no doubt soon be submerged by the universal recognition which this outstanding work deserves. The detection of interstellar polarization will always remain one of the most striking examples of a purely accidental discovery, such as Roentgen's discovery of X-rays. It required exceptional instrumental skill to detect the small variations of the light of a star as the analyzer was turned, but even more important was the quick realization that the effect was completely new and in no way foreshadowed by previous work.

There are now open new vistas for exploration. If Greenstein and Davis are correct, the needle-like particles must be oriented preferentially with their long dimensions perpendicular to the galactic plane. But collisions between them and the interstellar hydrogen, of which there is about one atom per cubic centimeter, would occur about once per day and would constantly disturb the orientation by compelling the needles to rotate in all possible directions, with an average angular velocity of 10^9 radians per second — almost like a molecule. This rotation must experience a braking action — perhaps as the result of hysteresis. The great frequency of these collisions contrasts with the extreme infrequency of collisions between grains — about once in 10^8 years, according to Spitzer — which nevertheless are sufficient, during the lifetime of the galaxy of 3×10^9 years, to produce enough ferromagnetic needles by evaporating the lighter substances off their surfaces.

It is rather interesting that, after we had been inclined for some years to disregard C. Schalén's view that most interstellar grains consist of iron, this new turn of events again gives prominence to his hypothesis. But it is not yet certain that the scattering processes which we observe in the main unpolarized light from stars and nebulae are also affected by the metallic particles. It is possible that particles of ice and similar substances account for most of the purely photometric results of the transmitted and scattered light, while iron needles account for the polarizing properties. At the same time we should not lose sight of the possibility that ice crystals, among others, are powerful polarizers; perhaps there exists in interstellar space a mechanism which lines them up in the same way as the earth's atmosphere lines them up when they produce various kinds of halos.

START ASTRONOMY EARLY

The May issue of *School Science and Mathematics* contains a forceful plea by Henry E. Crull, Butler University, Indianapolis, for the more universal introduction of astronomy into the junior high school curriculum. He refutes the idea that astronomy is necessarily a costly subject:

"We have acquired a frame of mind which encourages the belief that astronomy has become an area of esoteric knowledge for the elect.... It is my thesis today that this unencouraging point of view need not govern our approach to the problem of a unit in astronomy on the junior high school level (nor on any other level, for that matter).... Much of the effectiveness of the unit will be lost if we fail to keep before us always the goal of relating this unit with the others in science.... Astronomy does not stand alone or isolated. The discoveries and wonders of astronomy are simply ingenious projections of earthly knowledge and experiences."

TERMINOLOGY TALKS—J. Hugh Pruett

"Royal Sunspot Zone"

Sunspots are usually found in the band extending from about 35° north latitude on the sun across the solar equator to 35° south latitude, and rarely do they appear in latitudes higher than 40° in either solar hemisphere. This forms the "royal sunspot zone," as it was called by the late Dr. Clyde Fisher.

At the beginning of each sunspot cycle (discussed last month) spots usually appear at high latitudes, and as the cycle advances the most prominent spots form in positions gradually nearer the sun's equator, so at the time of maximum, latitudes of about 14° are the most thickly populated with spots. They seldom appear nearer the equator than 5°, and while some of the old-cycle spots are still visible around this location, those belonging to the new cycle are usually starting at around 30°. In a few instances, sunspots have formed close to the sun's equator.

Zeeman Effect

The spectroscope, an instrument indispensable in modern astronomy, will be described in a future Terminology Talk. It is a device to analyze the light from any source, generally by means of the positions of lines and bands of various colors (wave lengths) that may be seen in the eyepiece of the spectroscope or photographed through the instrument.

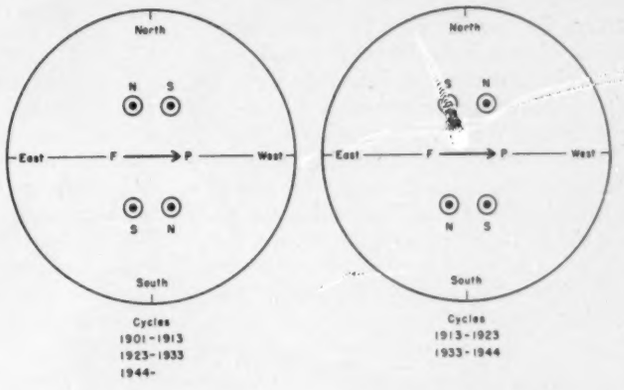
When the light to be analyzed passes between the poles of a strong horseshoe magnet or electromagnet, many spectroscopic lines that are ordinarily single appear to widen and split into two or three parts. In the case of a horseshoe magnet, in which the strongest lines of magnetic force extend directly between the poles at the ends of the horseshoe, let us suppose the light is viewed through a hole cut in one of the magnetic poles in such a way that the other pole can be seen through it. If the light source is placed between the poles, the rays of light will then come to the spectroscope in lines parallel to the magnetic lines of force. In this case, many of the spectral lines will be doubled. If, however, the light is observed from the flat side of the magnet so that the rays come off at right angles to the magnetic lines, the spectral lines will be tripled.

This splitting of spectral lines by a magnetic field is known as the Zeeman effect. The separation of the lines becomes greater with increased strength of the field, and the Zeeman components of the spectral lines are polarized in such a way that the direction in which the magnetic lines extend (that is, from north to south polarity) can be determined.

Magnetism in Sunspots

Zeeman discovered his effect in the laboratory in 1896, and in 1908 George Ellery Hale at Mount Wilson Observatory announced that the Zeeman effect had been observed in the spectra of sunspots. For spots located near the center of the sun's disk, the spectral lines are doubled, whereas from spots near the sun's edge or limb, the lines are tripled. This means that the magnetic lines of force from the central spots lie along the observer's line of sight, while near the limb the magnetic field extends at right angles to the line of sight. In either case the magnetic lines are at right angles to the solar surface. (Differentiate carefully between the three uses of the word "line" above.)

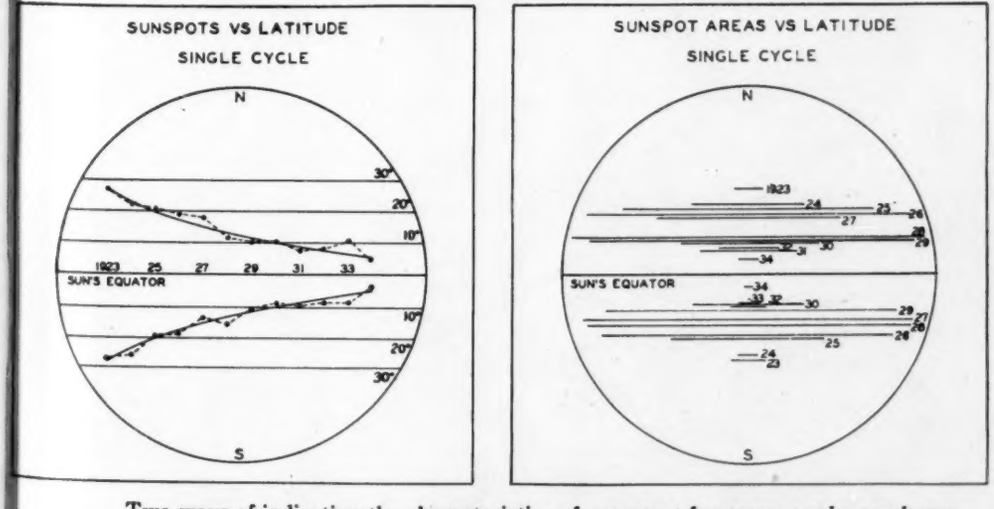
What could account for these huge solar magnets? Other studies indicate that sunspots are vortices of great masses of solar gas, which may be rich in free electrons. Moving electrons constitute an electric current, and traveling in generally circular directions may produce magnetic fields. It is not proven, however, which comes first, the sunspot or the magnetic field, for the latter is usually of too great an intensity to be entirely the result of the motion of gases in the sunspot. As with the sunspots themselves, the origin of their magnetic fields is at present unknown, and may long remain a puzzle.



The magnetic polarities of the preceding and following members of a sunspot group are opposite in the north and south hemispheres. They are reversed in alternate cycles, as shown by this chart of five cycles.

Magnetic Reversals in Sunspots

In the case of well-formed leader and follower spots (described last month), the two are of opposite magnetic polarity during any single cycle (averaging 11.2 years). The leaders north of the equator may, for example, have north magnetic polarity while the followers are south poles. At the same time, however, this condition is just the opposite in the southern hemisphere, with the leaders having south polarity and the followers north polarity. When the spots of the next cycle come on, there is a complete reversal of all these conditions in both hemispheres. The northern leaders then become south magnetic poles and all the others change accordingly. There are, however, some irregularities to be found at all times. The magnetic reversal indicates the fundamental cycle of solar activity to be 22.4 years long.



Two ways of indicating the characteristics of a sunspot frequency cycle are shown in these diagrams. On the left the change in the average solar latitude of sunspots during a cycle is illustrated. On the right, the variation in total spottedness, represented by the length of the horizontal line associated with a year, is plotted at the average solar latitude of the spots for that year.

NEWS NOTES

By Dorrit Hoffleit

SURVEY TRANSFERRED TO SOUTH AFRICA

A 10-inch refractor, used at Mount Wilson Observatory since 1914 in a survey of the Milky Way for planetary nebulae and bright-line *B*-type stars, has been lent to the Lamont-Hussey Observatory at Bloemfontein, South Africa. There a University of Michigan graduate student, Karl G. Henize, will complete the survey of the southern Milky Way under Dr. Leo Goldberg, director of the University of Michigan Observatories. Approximately three years will be required. Red-sensitive plates are used, to record especially the light of the hydrogen-alpha line.

Be stars and planetary nebulae have the common characteristic of a shell of hydrogen gas with an emission spectrum, but in the planetary nebulae the shell of gas is so large it can be seen directly rather than inferred from the spectrum. Since the survey was begun at Mount Wilson the number of known *Be* stars has increased from about 130 to more than 1,000, while the number of planetary nebulae known has doubled, to about 260 at present.

THE STELLAR MAGNITUDE OF THE SUN

The general advance in methods for measuring stellar brightnesses in recent years has prompted astronomers at the Commonwealth Observatory, Mt. Stromlo, Australia, to make a determination of the apparent and absolute magnitudes of the sun. In the *Monthly Notices* of the Royal Astronomical Society (Vol. 108, No. 6, 1948, page 491), R. v. d. R. Woolley and S. C. B. Gascoigne point out that the greater precision of modern devices could be adequately exploited only if monochromatic rather than visual magnitudes were measured. The results at four wave lengths (6209, 5550, 4945, and 4510 angstroms) gave an average photovisual magnitude for the sun of −27.07, and an absolute magnitude of +4.52.

Spectra of the sun, suitably weakened, and of Sirius were photographed on the same plate with the same exposure times, and the intensities at the four selected wave lengths were compared by standard methods of photographic photometry. Thus, the monochromatic magnitude differences between the sun and Sirius were established, and then allowance for the color differences of the two stars was made. From Kuiper's reduction of Zinner's catalogue, an apparent magnitude of −1.52 was adopted for Sirius, although other determinations differ from this by as much as 1/10 magnitude. The resulting magnitude of the sun, −27.07, is to be compared with the recent determinations by Calder (−26.22) and Pettit (−26.94), and with Kuiper's mean from the work of many observers (excluding Calder) of −26.84. Thus, the new value is about a fifth of a magnitude brighter than hitherto assumed.

In a note added in proof, the Australian astronomers report on a photoelectric determination now being made to ascertain a new value for the magnitude of Sirius. Preliminary results at Mt. Stromlo indicate that the magnitude of Sirius used is too high, and that the magnitude on the international photovisual scale will turn out to be about −1.3. This would bring the sun's absolute magnitude to about −26.9, in satisfactory agreement with earlier determinations.

THE "MISS CANNON OF THE WEST"

On July 1st, after 42 years of devoted service, Miss Cora G. Burwell retired from the staff of Mount Wilson Observatory. She had graduated from Mt. Holyoke College in 1906 and came to Mount Wilson the following year. For 15 years she assisted Drs. George Ellery Hale and Walter S. Adams, founder and director, respectively, on many solar and stellar problems. Since 1922 she has collaborated with Dr. Paul Merrill on problems in stellar spectrum analysis, specializing primarily in the discovery of stars whose spectra show emission lines, particularly those peculiar stars having red atmospheres of glowing hydrogen. When Dr. Merrill and Miss Burwell began their systematic search of the Milky Way for such stars, only some 100 peculiar bright-line stars were known. Now the list numbers 1,088, of which these investigators alone have contributed over 800. Miss Burwell, to whom astronomers have referred as "the Miss Cannon of the West," has also discovered several novae by their spectra, the most important of which she found in Sagittarius in 1947.

Upon her retirement, her colleagues at Mount Wilson honored Miss Burwell at an informal reception, when they presented her with a radio for her new home in Monrovia.

CANNON MEMORIAL VOLUME

A volume of the Harvard *Annals* containing the completion of Dr. Annie J. Cannon's classification of the spectra of faint stars has just been published by Harvard College Observatory. It contains 275 quarto charts, negative reproductions of photographs made with a patrol camera. The charts give the positions, spectral classes, and Henry Draper numbers of 86,932 stars. The fields covered are largely in the Milky Way in the constellations of Aquila, Cygnus, Taurus, Orion, Monoceros, Carina, Sagittarius, and Scorpius. Final work on this volume was done by Mrs. Margaret W. Mayall.

The frontispiece is a fine picture of Miss Cannon at her plate frame. Although some special gifts were made toward preparation of the volume, free distribution will not be possible, as has been the custom with most of the Harvard *Annals* of the past. The price has been set at five dollars a copy, postpaid.

EXCHANGE OF PERIODICALS

Scientists will be interested in the outcome of discussions at UNESCO in Paris in September, on the greater freedom of exchange of all types of printed matter (books, magazines, and newspapers) among nations. According to Science Service, the draft of a proposed agreement calls for granting freedom from customs duties and import licensing systems and extension of foreign exchange facilities for the purchase of publications. At the same time safeguards for domestic publishing industries are provided.

MAGNETIC AND GEOMAGNETIC EQUATORS

Not everyone is aware of the distinction between the magnetic equator and the geomagnetic equator. A letter by K. S. Raja Rao, of the Solar Physics Observatory, Kodaikanal, India, to the editor of *Current Science* (Bangalore), April, 1949, explains the difference. The magnetic equator is determined from measurements of the dip angle of a free magnet in the earth's field (dipping needle), the equator corresponding to the zero angle. On the other hand, calculations based on the assumption that the earth's magnetic field is best represented by a small but powerful dipole at the geometric center of the earth determine geomagnetic latitudes. The two are not the same.

As for the electrified layers in the earth's upper atmosphere, measurements of the polarization of radio waves by Wells and Berkner, and of critical F2 layer frequencies by Appleton and Liang, indicate that geomagnetic rather than magnetic latitudes determine the control of the earth's magnetism over the ionosphere.

A better approximation to the observed magnetic field of the earth is obtained on the assumption of a dipole displaced 342 kilometers from the earth's center in the direction of longitude 162° east and latitude 6½° north, with its axis parallel to the line through the earth's center and the geomagnetic pole. Vallarta has shown that the resulting asymmetry of the magnetic field accounts for observed characteristics of incoming cosmic rays.

AMERICAN ASTRONOMERS REPORT

Here are highlights of some papers presented at the 81st meeting of the American Astronomical Society at Ottawa, Canada, on June 19-22. Complete abstracts will appear in the Astronomical Journal.

The Russell Lecture*

TURBULENCE was the subject of the third Henry Norris Russell lecture, given by Dr. S. Chandrasekhar, of Yerkes Observatory, on June 21st. The lecturer began his theme as follows: Rosseland, in 1928, first drew attention clearly to the importance for astrophysics of turbulence with its correct hydrodynamical meaning. He pointed out that if differential motions — of one part relative to another — occur in cosmical gas masses, then the motions should be turbulent in the sense that we should not expect to describe them in terms of the classical equations of motion of Stokes and Navier.

Linear flow of water in a tube can be obtained only for velocities below a certain critical limit above which laminar flow ceases and a complex, irregular, and fluctuating motion sets in. In general, motions governed by the equations of Stokes and Navier change into turbulent motion when a certain nondimensional constant called the Reynolds number exceeds a certain value of the order of 1,000. This Reynolds number depends on the product of the linear dimension of the system, the density, and the velocity, and is inversely proportional to the coefficient of viscosity.

Since the Reynolds number depends directly on the linear dimension of the system, Rosseland argued that motions in the oceans, in terrestrial and planetary atmospheres, and still more in stellar atmospheres, once they occur, must become turbulent in this sense. He further pointed out that if turbulence develops the coefficients of viscosity and heat conduction may be expected to increase a millionfold, producing a highly enhanced efficiency of heat and momentum transport.

Stimulated by Rosseland's ideas, McCrea suggested in the same year that the solar chromosphere must be in a state of turbulence and that this turbulence may, in part, contribute to its support against gravity. About a year later Jeffreys pointed out that if the generation of energy inside a star is confined to a small region at the center, then the radiation will not be able to dispose of it at a gradient under the adiabatic,† and that if a superadiabatic gradient comes into being, vertical currents will be generated which will effectively restore the adiabatic gradient, leaving, however, a slightly superadiabatic gradient to enable the transport of heat. With the clarification of the source of stellar energy as due to nuclear transformations, it is now generally recognized that all stars must have convective cores in which turbulence prevails. And as was shown, particularly by Cowling, the existence of turbulence is of primary importance in all considerations relating to the stability of stars.

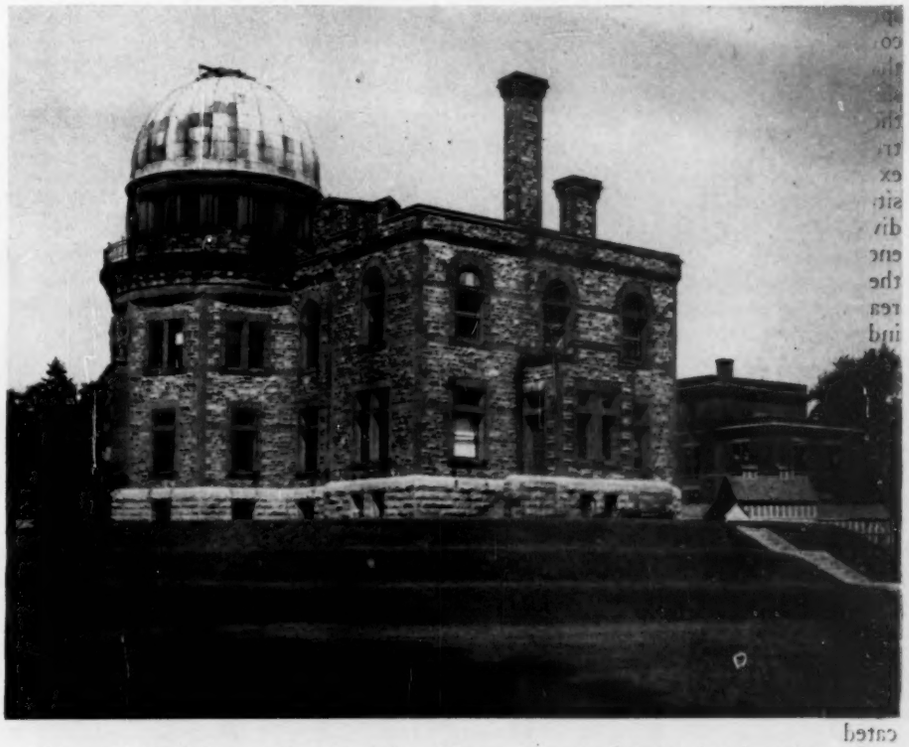
Dr. Chandrasekhar went on to describe the necessity to call on turbulence to explain spectral line profiles: the Doppler effect due to thermal motions alone must be supplemented with large-scale motions of a turbulent nature. In the solar atmosphere, granulation of the photosphere must be related to the hydrogen convection zone believed to exist deep in the photosphere where hydrogen begins to get ionized.

Struve and his associates during the past few years have shown that the shells surrounding early-type stars and the gaseous envelopes in which spectroscopic binaries are frequently embedded must also be turbulent. And finally, Dr. Chandrasekhar stated, it would appear that the interstellar clouds must also be in a state of turbulence, for, assuming that a typical cloud is 10 parsecs in diameter, that relative motions to the extent of 10 kilometers per second occur, we find that the Reynolds number must be of the order of 10^5. The motions inside the cloud must therefore be turbulent. The even larger question now occurs of whether or not we may regard the clouds of various sizes in interstellar space as eddies in a medium occupying the whole of the galactic space.

From the physical picture standpoint, Dr. Chandrasekhar described a turbulent medium as one in which there are eddies that spontaneously form and disintegrate. This process goes on continuously. Each eddy travels a certain average distance with a certain average speed before it loses its identity. But this picture requires a physical theory to justify it, and to begin his presentation of such a theory, the Russell lecturer asked the question:

"What is the reason that a phenomenon like turbulence can occur at all?"

The answer, he said, must be that an ideal fluid is a mechanical system with a very large number of degrees of freedom and that, in consequence, it is theoretically capable of a very large number of different types of motions. Laminar motion is only one of many possible motions, and the problem of



The main building of the Dominion Observatory at Ottawa, headquarters of the host astronomers at the 81st meeting of the American Astronomical Society. Open house and a garden party were held here on the evening of June 20th.

*This account is extracted and condensed from "Turbulence — A Physical Theory of Astrophysical Interest," by S. Chandrasekhar.

†In adiabatic equilibrium, the energy of a given mass of gas remains unchanged under varying conditions of temperature and pressure.

turbulence is therefore a statistical one of specifying the probability with which the various types of motion may occur and are present. Stated in this way, the problem of turbulence has an analogy with that of analyzing a continuous spectrum of radiation, as, for instance, from a black body.

Considering the state of motion of a medium at any given instant, we may analyze the fluctuating velocity field as the result of superposition of periodic variations with all possible wave lengths. A component with a certain wave length may be pictured as corresponding to an eddy of that size, and since many wave lengths are needed to represent a general velocity field, we may speak of a hierarchy of eddies, limited on the side of long wave lengths by the fact that no eddy of size larger than the dimension of the medium can occur.

Referring to the optical analogy, under conditions of equilibrium, the distribution of energy in the continuous spectrum will be that given by Planck's law, no matter what the initial distribution of energy is. In contrast, turbulence can be maintained only by an external agency, such as continuous stirring, the energy available from thermal instability, or from rotation in a differentially rotating atmosphere. In other words, energy is required for the maintenance of turbulence; in the absence of such an agency turbulence will decay and the spectrum will be a function of time.

Considering the spectrum of turbulence under stationary conditions, the presence of an external agency requires distinction between the region of the spectrum in which the eddy sizes are comparable to the linear dimension of the system and the region with eddy sizes small compared to the system. In the first region, the nature of the spectrum will depend on the nature of the external agency and the theory of each situation will have to be analyzed individually. But the distribution of energy among eddies small compared to the dimension of the system may not unreasonably be supposed to be largely independent of the agency and to depend only on the rate at which energy is being supplied. The spectrum should approach a universal one depending only on the energy and the viscosity, and as the Reynolds number tends to infinity more and more of the spectrum will follow a universal law. When this is the case, we have the equilibrium spectrum for a fully developed turbulence. In astronomical contexts, turbulence when it occurs may be expected to be fully developed in this sense.

The energy supplied by the external agency may be assumed to be communicated principally to the largest eddies, while the dissipation into thermal energy by viscosity will be effected principally by the smallest eddies, in which the motions may be expected to be laminar. Consequently, energy at the original rate must flow through the entire hierarchy of eddies, but between the largest eddies and the smallest ones (for very large or infinite Reynolds number) there should be a large range in which the spectrum may be expected to become independent of the viscosity as well and depend only on the rate of energy transfer.

Dr. Chandrasekhar pointed out that these ideas which underlie the recent developments in the theory of turbulence were first clearly recognized by L. F. Richardson, to whom the following rhyme is attributed:

Big whorls have little whorls which
feed on their velocity,
Little whorls have smaller whorls
and so on unto viscosity.

As for a decay spectrum, one might postulate that an initially equilibrium spectrum had the agency maintaining the turbulence suddenly cut off. Then, in the decay of turbulence which would ensue one may distinguish three stages: an early stage during which the larger eddies adjust themselves to the fact that no energy is being communicated to them; an intermediate stage during which there is a sufficient store of energy among the larger eddies to maintain an equilibrium distribution among the lower members of the hierarchy and the Reynolds number remains constant; and finally a last stage during which the store of energy among the larger eddies is getting exhausted and the Reynolds number decreases to zero.

In his concluding discussion, Dr. Chandrasekhar described the use that von Weizsaecker has made of turbulence in his recent general cosmogonical theory. The Yerkes astronomer complimented von Weizsaecker on "a restraint and modesty which is unusual among writers in this field," and pointed out that his emphasis on the role of turbulence in cosmogony caused Heisenberg to examine the basic physical theory leading to our present-day foundations of a theory of turbulence. Von Weizsaecker's theory rests on the effects he expects from the interplay of rotation and turbulence, and this Dr. Chandrasekhar considers of vital importance, without at the same time subscribing to the German astronomer's detailed picture of the manner in which he expects turbulence to operate in the gases of a galaxy or about a star.

Consider a sheet of gas at very low density in the equatorial plane of a central mass which may be identified as a star or the nucleus of a galaxy. If we ignore, in the case of the star, the effects of pressure and viscosity, each element of gas will describe a Keplerian orbit, and the successive rings of gas in the medium will, therefore, have motions relative to one another and turbulence will ensue. Viscous stresses will come into play and will perturb the motions both in the radial and transverse directions. Examining the sense of these perturbations, von Weizsaecker concludes that all matter interior to a certain critical radius will fall towards the center while the matter outside this radius will tend to move outwards and dissipate into space. This mechanism von Weizsaecker uses to account for the dissipation of a gaseous envelope which he supposes once surrounded the sun and in which he presumes the solar system was formed. He also uses it to interpret the ring structure in extragalactic nebulae, and to explain the linear dimensions of the present galaxies in an expanding universe.

Dr. Chandrasekhar's concluding words were: "It would seem therefore to me that we cannot expect to incorporate the concept of turbulence in astrophysical theories in any essential manner without a basic physical theory of the phenomenon of turbulence itself. It appears that the first outlines of such a physical theory are just emerging."

Plate-Measuring Machine

IN PRELIMINARY FORM, Harold L. Johnson, formerly at Lick Observatory and now at Washburn Observatory, has constructed an electronic machine for measuring the positions of lines of spectrograms. The machine offers the advantages of near-elimination of eyestrain and fatigue, elimination of personal equation, increased speed of measurement, and increased precision.

The first two advantages result because the machine is almost completely automatic — the operator has only to select a line and to push a button. The machine then scans the line and determines its position as midway between two equal-intensity points on the line profile. The reading of the calibrated screw head is then recorded automatically on photographic film.

The ideal way of measurement would be with two scanning slits and two photocells, but constancy of the photocells would be uncertain. In Mr. Johnson's apparatus only one slit and one photocell are used, with a small vibrating mirror to sweep an image of the line back and forth across the slit. A synchronous detector then "looks" at the line only at the extreme ends of the mirror swing. Unsymmetrical lines can be measured by settings for various widths of mirror swing.

The probable error is very small in comparison with the line width, and a single machine setting is as good as several. Primary source of error is, as with visual measures, the grain of the photographic plate, but greater *average* accuracy is obtainable with the machine because there is no operator fatigue. This is especially so in the measurement

of the wide hydrogen lines in the early-type stars, for which work the machine was designed and will be most useful. Spectrograms of the star Mu Cephei, using only four hydrogen lines, have been measured at the rate of eight per hour.

LETTER TO THE EDITOR

Sir:

It has occurred to me that you might be interested to know, regarding the Neptune photograph on page 254 of the August issue, taken at McDonald Observatory, that the fuzzy images are all galaxies. They are about as numerous as the stars in the field.

GERARD P. KUIPER
Yerkes Observatory
Williams Bay, Wis.

NOVA IN SCUTUM

At Meudon Observatory, on July 31st, C. Bertaud discovered a nova of magnitude 9.6 in the position $18^h\ 50^m.9$, $-4°\ 16'$ (1900 co-ordinates). At McDonald Observatory, Guido Munch found the magnitude to be 8.5 on August 4th. The spectrum is *F*5 without emission lines in the photographic region, according to V. Kourganoff and Miss Canavaggia at McDonald.

Leon Campbell, recorder of the AAVSO, notes that the nova follows Beta Scuti (magnitude 4.5) by $8^m.7$ and is north of it 35′. The position can be identified on an "a" chart of R Scuti. On a Harvard plate taken August 5.247 UT, the photographic magnitude has been found to be 8.3.

Amateur Astronomers

SACRAMENTO ACTIVITIES

At Sacramento, Calif., from September 1st to 11th, the California State Fair, attended by some 600,000 people annually, will have an exhibit by the Sacramento Valley Astronomical Society. Among other items in the display will be transparencies furnished by Lick Observatory, and a 1/16 scale working model of the projected Lick 120-inch reflecting telescope.

The committee in charge of preparations for the exhibit includes C. A. Fogus, H. J. Simmonds, and William A. Ervin. In addition to preparing the exhibit, the society provides two people at its booth at all times, from 10 a.m. to 10 p.m. for the days of the fair, to explain the exhibits and answer questions.

As another activity in its program of furthering popular interest in astronomy, this summer a series of open-air star study classes is being held at various points in the Sacramento Valley with Paul Steele as lecturer. Members of the society are also staffing the observatory at Sacramento Junior College one night a week in order to provide an open night for the general public during the school vacation period.

We have recently come into possession of a fine 8-inch portable reflector, which is being made available on loan to astronomy and science classes in local schools. The instrument is the gift of Dr. Robert E. Smith, a director of the society, and Dr. Nathan G. Hale, a nephew of the late George Ellery Hale.

Recent additions to the observatory at Sacramento Junior College, headquarters of the society, include the mounting of a 4-inch refractor alongside the 12½-inch reflector; a camera with an f/6.3 lens of 6-inch focal length; a Bausch and Lomb direct-vision spectroscope; and finally, a Cooke lens of 13 inches focus, f/8, on loan from Harvard College Observatory and the Milwaukee Astronomical Society for taking photographs of comets and the Milky Way.

CARL W. ANDERSON
Route 5, Box 7624
Sacramento, Calif.

NORTHWEST CONVENTION

The annual convention of the Northwest region of the Astronomical League will be held at Portland, Ore., on Saturday and Sunday, September 3rd and 4th. The meetings will take place mainly in the auditorium of the Oregon **Journal** building, with the exhibit of instruments and photographs on the mezzanine floor.

T. P. Maher, Arlington, Ore., is taking care of hotel accommodations. The program is being planned by the regional chairman, James H. Karle, of Portland. The exhibit committee is headed by Norman C. Smale, according to **The Observer**, published by the Yakima Amateur Astronomers.

THIS MONTH'S MEETINGS

Detroit, Mich.: On Sunday afternoon, September 18th, at 3 o'clock in State Hall, Wayne University, the Detroit Astronomical Society will hear talks by the delegates who attended the Astronomical League convention in Cleveland. Delegates from all Michigan societies are invited to take part.

Indianapolis, Ind.: A sky party and picnic under the direction of the board of officers will be held by the Indiana Astronomical Society on September 4th, at Link Observatory in Brooklyn, Ind. Indiana and Butler universities, the Nature Study Club, and the public will participate.

Kalamazoo, Mich.: The Kalamazoo Amateur Astronomical Association is holding a pot-luck supper at Wolf Lake Lodge, 12 miles west on M-43, on September 10th at 6:00 p.m. Keith A. Pierce, of the McMath-Hulbert Observatory, will speak. Members of all amateur groups in Michigan are invited to attend.

Pittsburgh, Pa.: The Amateur Astronomers Association of Pittsburgh meets on September 9th at the Buhl Planetarium, 8:00 p.m. H. Malcolm Priest will lecture on "Solar and Lunar Eclipses."

Washington, D. C.: The National Capital Astronomers will meet on Saturday, September 10th, at 8 p.m. in the Commerce Building auditorium. Dr. B. W. Sitterly, of American University, will speak on "The Shape of Our Universe."

Planetarium Notes

BALTIMORE: *Davis Planetarium.* Maryland Academy of Sciences, Enoch Pratt Library Building, 400 Cathedral St., Baltimore 1, Md., Mulberry 2370.

SCHEDULE: 4 p.m. Monday, Wednesday, and Friday; Thursday evenings, 7:45, 8:30, 9:30 p.m. Admission free. Spitz projector. Director, Paul S. Watson.

BUFFALO: *Buffalo Museum of Science Planetarium.* Humboldt Parkway, Buffalo, N. Y., GR-4100.

SCHEDULE: Sundays, 2:00 to 5:30 p.m. Admission free. Spitz projector. For special lectures address Elsworth Jaeger, director of education.

CHAPEL HILL: *Morehead Planetarium,* University of North Carolina, Chapel Hill, N.C.

SCHEDULE: Daily at 8:30 p.m.; Saturday and Sunday at 3:00 p.m. Zeiss projector. Director, Roy K. Marshall.

CHICAGO: *Adler Planetarium.* 900 E. Achsah Bond Drive, Chicago 5, Ill. Wabash 1428.

SCHEDULE: Mondays through Saturdays, 11 a.m. and 3 p.m.; Sundays, 2:30 and 3:30 p.m. Zeiss projector. Director, Wagner Schlesinger.

LOS ANGELES: *Griffith Observatory and Planetarium.* Griffith Park, P. O. Box 9787, Los Feliz Station, Los Angeles 27, Calif., Olympia 1191.

SCHEDULE: Wednesday and Thursday at 8:30 p.m.; Friday, Saturday, and Sunday at 3 and 8:30 p.m.; extra show on Sunday at 4:15 p.m. Zeiss projector. Director, Dinsmore Alter.

NEW YORK CITY: *Hayden Planetarium.* 81st St. and Central Park West, New York 24, N. Y., Endicott 2-8500.

SCHEDULE: Mondays through Fridays, 2, 3:30, and 8:30 p.m.; Saturdays, 11 a.m., 2, 3, 4, 5, and 8:30 p.m.; Sundays and holidays, 2, 3, 4, 5, and 8:30 p.m.; Wednesdays and Fridays, 11 a.m., for school groups. Zeiss projector. Curator, Gordon A. Atwater.

PHILADELPHIA: *Fels Planetarium.* Franklin Institute, 20th St. at Benjamin Franklin Parkway, Philadelphia 3, Pa., Locust 4-3600.

SCHEDULE: 3 and 8:30 p.m. daily except Mondays; also 2 p.m. on Saturdays, Sundays, and holidays; 11 a.m. Saturdays, Children's Hour (adults admitted). Zeiss projector. Director, I. M. Levitt.

PITTSBURGH: *Buhl Planetarium and Institute of Popular Science.* Federal and West Ohio Sts., Pittsburgh 12, Pa., Fairfax 4300.

SCHEDULE: Mondays through Saturdays, 2:15 and 8:30 p.m.; Sundays and holidays, 2:15, 3:15 and 8:30 p.m. Zeiss projector. Director, Arthur L. Draper.

SPRINGFIELD, MASS.: *Seymour Planetarium.* Museum of Natural History, Springfield 5, Mass.

SCHEDULE: Tuesdays, Thursdays, and Saturdays at 3 p.m.; Tuesday evenings at 8 p.m.; special star stories for children on Saturdays at 2 p.m. (Closed July to mid-September.) Admission free. Korkosz projector. Director, Frank D. Korkosz.

STAMFORD: *Stamford Museum Planetarium.* Courtland Park, Stamford, Conn.

SCHEDULE: Showings by request only, during summer months, until October. Admission free. Spitz projector. Director, Ernest T. Ludhe.

Two telescope makers get instruction in laying out the glare stop and eye lens washers from Lester Nells, one of the Junior Astronomy Club instructors. Photo by the Cleveland "Press."

TELESCOPES FOR JUNIORS

BY FRANK A. MYERS, *Junior Astronomy Club*
Cleveland Museum of Natural History

LOTS OF TEEN-AGE boys and girls would like to make a telescope. Most of them don't make them, because they don't know how, and the cost is too high. Some Cleveland folks thought something ought to be done about it. The result was the formation of our Junior Astronomy Club. (See May, 1949, *Sky and Telescope,* page 172.) Interest in telescope making has so far exceeded our expectations that we believe other communities may be interested in what we have done.

The Cleveland Museum of Natural History felt that astronomy could be made a museum activity among school boys and girls. Harold T. Clark, president of the museum, discussed the subject with Dr. J. J. Nassau, president of the Cleveland Astronomical Society. Together they talked with heads of school science departments. The museum was willing to furnish a club room and to equip a workshop with tools for telescope making. Members of the society who had made their own telescopes would act as instructors. The schools felt that homemade telescopes would be splendid science projects for pupils.

Sponsors' meetings were held in January, 1949. All persons were so enthusiastic that in February the Junior Astronomy Club was launched, and over 200 school boys and girls attended the organization meeting. Nearly 90 per cent of them wanted to make telescopes; without question there was a widespread desire for each teen-ager to have his own instrument. But differences in age and skill indicated the need for three different groups of telescope makers in the Junior Astronomy Club program.

The grinding and polishing of a mirror for a reflecting telescope had great appeal for juniors 14 years of age and up. Many adults also wanted to make mirrors. This group standardized on producing 6-inch mirrors with simple wood and pipe fitting mountings, under the leadership of James L. Russell, who is an amateur astronomer and telescope maker of long standing.

A second group were specialists, composed mostly of high school and college students, and older persons. Some wanted to assemble binoculars from war-surplus kits. Others wanted to use war-surplus lenses to make a high-powered terrestrial or astronomical refractor. Some had ground 6-inch mirrors and wanted to make larger ones. Others wanted help in the design of telescope mountings.

Richard P. Tappenden and I have had experience in boy scout and school handicraft work. We felt that many

boys and girls *under 14 years* of age wanted to make telescopes. But youngsters 10 and 12 years old do not usually have the manual skill or the perseverance to spend 50 hours grinding and polishing a mirror. At these ages they assemble model airplanes and model trains. The article in this issue's Gleanings for ATM's department (page 288) gives the technical details of the kit of parts we developed for making an 8-power astronomical telescope, at a total materials cost of $1.50, including the lenses.

For this beginner's telescope we set up the following goals:

1. The *design* must be simple, and require mostly assembly operations.

2. The *time* required for completion should not be over three or four afternoons. We wanted completed telescopes before the youngsters became discouraged or lost interest.

3. The *manual skill* required should be of the junior high school age level. Tools must be simple, and as much fabrication as possible done by the beginner.

4. *Instructions* must be simple enough to enable easy training of instructors to carry on the program as a school activity.

5. The *cost* of lenses and parts must be under $2.00.

The museum purchased all of the tools for the club. Hand tools costing about $75.00 have accommodated a group of 30 telescope makers at one time. This does not include a drill press, band saw, and a filing and polishing unit used by both the beginner's and mirror-grinding groups. If you can afford enough tools you can have everyone do the same operation at the same time. But with 30 to 35 persons in our groups we did not buy over 12 each of even the simple tools, because of cost. So we run a six-ring circus — a number of small groups each doing a simple operation at the same time. If there are enough instructors so that each one can start a separate small group, then no one has to wait before starting the next operation. Workers with more skill are not held back by slower workers.

A group works on sanding the burrs off metal tubing. Cleveland "Press" photo.

For the first 100 telescopes, I used my own metal-cutting band saw at home to cut the tubing to size for rings and spacers. When the activity started to spread through the Cleveland schools, the museum purchased a metal-cutting band saw for the club workshop. Three of our instructors have woodworking tools at home. Two have lathes and metal-cutting equipment. We had a lot of fun designing and making various jigs, fixtures, and "Rube Goldberg" contraptions for making the telescope parts. These jigs enable the drill press to perform many operations that would normally be done on a lathe, which we did not have.

Two groups at a time make beginner's telescopes in the club. One class meets Saturday afternoons, the other Sunday afternoons. Each group meets every two weeks, for three meetings.

Each meeting starts with about 20 minutes of movies or a demonstration of optics in the museum auditorium. We use the Erpi films: The Solar System, The Earth in Motion, The Moon, and the Harvard film, Explosions on the Sun. The last fits in with a talk on atomic energy. Each member is given a copy of the Graphic Time Table of

Members of the second beginner's group pose with their 8-power astronomical telescopes, completed in three meetings at the Junior Astronomy Club workshop. Photo by Richard P. Tappenden.

WAR SURPLUS BARGAINS

Government's 7 X 50 Binoculars

Assemble Them Yourself! Complete Optics! Complete Metal Parts! Save More Than ½ Regular Cost!

METAL PARTS—Set includes all metal parts—completely finished — for assembly of 7 X 50 Binoculars. No machining required. Sturdy Binocular Carrying Case is optional with each set of Metal Parts.
Stock #842-Y. $39.40 Postpaid, plus $4.80 for Case. Total $44.20

OPTICS—Set includes all Lenses and Prisms needed for assembling 7 X 50 Binoculars. These are in excellent condition — perfect or near-perfect — and have new low reflection coating.
Stock #5102-Y ..... $25.00 Postpaid

Note: These are fine quality standard American made parts (not Japanese, French or German).

NOTICE! If you buy both Binocular Optics and Binocular Metal Parts, add 20% Federal Tax.

ARMY'S 6 X 30 BINOCULARS

COMPLETE OPTICS & METAL PARTS—Model M-13A1, 6 x 30 Binoculars (Waterproof Model). Everything you need—ready for assembly. When finished will look like regular factory job costing $102 to $120. Optics are new, in perfect or near-perfect condition. Have new low reflection coating. Metal Parts new and perfect, all completely finished. Complete assembly instructions included.
Stock #830-Y ..... $40.00 Postpaid plus $8.00 tax—Total—$48.00

ASTROGRAPH FILM—Consists of 7 spools of film with a range from 45° south latitude to 68½° north latitude.
Stock #77-Y ..... $16.50 Postpaid

MOUNTED ANASTIGMAT LENSES — Use for Projectors, Enlargers, Copying Cameras. Complete with Shutter and Diaphragm. Value about $20. An excellent buy. WE WILL INCLUDE FREE ILLUSTRATED BOOKLET on HOW TO MAKE YOUR OWN ENLARGER.

Stock #8004-Y Speed f/7.7, focal length approx. 127 mm. Suitable for pictures, negatives, positives up to 3¼" x 4¼" ..... **$7.50 Postpaid**
Stock #8006-Y Speed of f/7.7, focal length approx. 100 mm. Suitable for pictures, etc. up to 2¼" x 3¼" ..... **$8.50 Postpaid**
Stock #8007-Y Speed of f/6.3, focal length approx. 100 mm. ..... **$9.50 Postpaid**

We have over 200 different sizes and focal lengths of Plano-Convex, Double Convex, Concave, and Meniscus Lenses, priced from 6c to 30c each. Write for Catalog Y.

MOUNTED TELESCOPE EYEPIECE — Kellner type. Excellent astronomical and other telescopes. War Surplus. Government cost about $18.00. Focal length 24 mm. Lens diameter 23 mm. Unusually wide field.
Stock #5189-Y ..... $3.25 Postpaid

ADAPTER MOUNT (not surplus)—2⅛" long with standard 1¼" O.D. for use on astronomical telescopes. Threaded so Stock #5189-Y screws into it. Black anodized.
Stock #5190-Y ..... $1.00 Postpaid

NEW BULLETIN on our BIG VARIETY OF PRISMS—Request Bulletin Y.

FIRST-SURFACE MIRRORS

Stock #539-Y—60 mm. x 80 mm. .. **75c Postpaid**
Stock #558-Y—45 mm. x 74 mm. .. **50c Postpaid**
Stock #547-Y—43 mm. x 140 mm. .. **50c Postpaid**
Stock #534-Y—25 mm. x 29 mm. .. **25c Postpaid**

TELESCOPE EYEPIECE—Consists of 2 Achromatic Lenses, F. L. 28 mm. in a metal mount.
Stock #5140-Y ..... $4.50 Postpaid

MOUNTED PROJECTING LENS SYSTEM

F.L. 91.44 mm. (just right for 35 mm. Projectors). Speed of f/1.9. Outside dia. of mount at one end 60 mm. Length of mount 54 mm.
Stock #4033-Y .. $3.00 Postpaid

THREADED OUTSIDE MOUNT FOR FOCUSING ABOVE SYSTEM (Not Illustrated) —
Stock #715-Y .. $1.00 Postpaid

SLIDE PROJECTOR SETS—Consist of all unmounted lenses you need to make the following size projectors:
Stock #4038-Y — 2¼" x 2¼" .... $3.35 Postpaid
Stock #4039-Y — 2½" x 3½" .... $3.35 Postpaid
Stock #4035-Y — 35 mm. ..... $4.85 Postpaid

We Have Literally Millions of WAR SURPLUS LENSES AND PRISMS FOR SALE AT BARGAIN PRICES. Write for Catalog "Y"—FREE!

Order by Stock No. *Satisfaction Guaranteed.*

EDMUND SALVAGE CO.
P. O. AUDUBON: NEW JERSEY

the Heavens, which we secure gratis from the Maryland Academy of Sciences.

Following the movies, we have about two hours of telescope making in the club workroom. The age group 10 to 16 years all finished their telescopes in three meetings. Boys and girls as young as eight and nine, and adults up to age 65, made telescopes in our first four groups.

Seven visual-aid charts are used,

Eight-year-old Robin Farran, youngest member of the first beginner's group, smooths tubing for a telescope. Cleveland "Press" photograph.

and these are reproduced in the Gleanings department article. Before making each telescope part, we explain the step-by-step operations, and the charts save answering a lot of questions later. We say, "Ask the chart first — if your question is not answered, then ask me." Full-size charts, printed on one side only to facilitate mounting, will be available this fall as part of a publication of the Cleveland Museum of Natural History.

The charts make instructing easier for a science teacher who may not be a good mechanic, and they are the key to moving the beginner's telescope from our club workshop to the schoolroom. Members of school telescope clubs join our club and meet at the museum for general lectures on astronomy. But they make their telescopes at their schools. The museum buys the various raw materials. The schools send picked students who have had machine-shop training to the club workshop, where they saw the required number of rings and spacers on the club band saw. They can see how our jigs and fixtures are made so as to make duplicates (or improved models) for their school telescope groups.

In mirror grinding, the skill of the instructor is not easily transferred to a student in a limited time. But in making the beginner's telescope, the skills are quite elementary. We instructed 16-year-old boys in our first Sunday group and used them as assistant instructors in a second group starting the following Saturday.

Examples of such school activity are numerous. Mr. Tappenden, a science teacher at Shaker Junior High School, is one of my assistant instructors in the beginner's telescope group. Four of his science pupils enrolled, told the rest of their science class about it, and as a result over 40 boys and girls from Shaker Junior High enrolled in a school telescope making club in the spring of 1949. Walter Smith, science teacher of East Technical High School, joined the first beginner's group for the express purpose of starting a club at his school.

The school manual arts program also ties in, for we use the simple manual skills of filing, sanding, painting, and gluing. Accurate layout and drilling are used in making the glare stop, eye lens cell, and eye plug. Wood jigs and fixtures for telescope making are good school manual training projects. Metal chucks and holding devices make good school machine-shop projects.

If a boy or girl makes a telescope of his own, the study of astronomy is fun. A youth's interest in astronomy does not really begin to grow until he has a telescope of his own to look through at the heavens. And from the kit of chipped lenses that we purchased for the instrument, seven are left to experiment with further. In our beginner's group, each member actually sets up his own lenses in an optical bench and proves the correct spacing of the objective, field, and eye lenses in the telescope he is making.

Each one of 173 members completed a beginner's telescope in the spring of 1949. In the advanced group 14 binoculars were assembled, seven 6 x 30 and seven 7 x 50 models. In the fall the lens telescope group of the club expects to repeat the 8-power beginner's telescope project, for which 325 sets of parts are already available, and to repeat the binocular assembly group. In addition there will be a group in the assembly of 1-inch Kellner eyepieces, each worth $8.00, but the kit to cost $2.00. There will also be Ramsden eyepiece assembly, at lower cost, but a lathe is needed for us to carry on this project. Similarly, for a 15- to 20-power achromatic 2-inch telescope, in metal tubing, a lathe is needed; the cost for each kit will be probably about $4.00. There are many other projects, such as employing discarded Warner and Swasey optical grinding equipment to make in quantity 2-inch achromatic lenses of long focal length.

What Cleveland has done and will do can be done in other communities.

HERE AND THERE WITH AMATEURS

*Members receive *Sky and Telescope* as a privilege of membership. †Member organizations of the Astronomical League.

State	City	Organization	Time	Meeting Place	Communicate With
ALABAMA	Gadsden	*Ala. A.A.*	7:30, 1st Thu.	Ala. Power Audit.	Brent L. Harrell, 1176*W* or 55
CALIFORNIA	Los Angeles	*L.A.A.S.*	7:45, 2nd Tue.	Griffith Obs.	H. L. Freeman, 853½ W. 57 St.
	Norwalk	*Excelsior Tel. Club*	7:00, Thu.	Excelsior Union H.S.	Geo. F. Joyner, 410 Sproul St.
	Oakland	**Eastbay A.S.*	8:00, 1st Sat.	Chabot Obs.	Miss H. E. Neall, 1626 Chestnut, B'keley
	Palo Alto	**Peninsula A.S*	7:30, 1st Fri.	Community Center	Miss D. Rossiter, 922 Roble Ave., Menlo Pk.
	Sacramento	**Sac. Val. A.S.*	8:00, 1st Tue., bi-mon.	Sacramento College	Mrs. B. Heathcote, 1820 G St., *Hudson* 4-1582
	San Diego	*Ast. Soc. of S.D.*	7:30, 1st Fri.	504 Electric Bldg.	W. T. Skilling, 3140 Sixth Ave.
	San Diego	*A.T.M. Ast. Club*	7:30, 2nd, 4th Mon.	3121 Hawthorn St.	G. A. Sharpe, 4477 Muir, *Bayview* 3757
CONNECTICUT	New Haven	†*New Haven A.A.S.*	8:00, 4th Sat.	320 York St.	Mrs. Eda Becroft, Box 28, Yalesville
	Norwalk	*Norwalk A.S.*	8:00, Last Fri.	Private houses	Mrs. A. Hamilton, 4 Union Pk., 6-5947
	Stamford	**Stamford A.A.*	8:00, 3rd Fri.	Stamford Museum	Wm. L. Dutton, Box 331, Noroton
DIST. COL.	Washington	†*Nat'l. Cap. Ast'mers*	8:00, 1st Sat.	Comm. Dept. Audit.	Janet Perkins, 2141 Eye St. NW (7), *Re* 7676
FLORIDA	Daytona Beach	*D. B. Stargazers*	8:00, Alt. Mon.	500 S. Ridgewood Ave.	Rolland E. Stevens, 500 S. Ridgewood
	Jacksonville	**J.A.A.C.*	8:00, 1st, 3rd Mon.	Private homes	E. L. Rowland, Jr., 442 St. James Bldg.
	Key West	†*Key West A.C.*	8:00, 1st Wed.	Private homes	W. M. Whitley, 1307 Div. St., 724-R
	Miami	*South'n Cross A.S.*	7:30, Every Fri.	M. B. Lib. Grounds	A. P. Smith, Jr., 426 S.W. 26 Rd.
GEORGIA	Atlanta	*Atlanta Ast'mers*	7:30, 3rd Fri.	Agnes Scott College	W. A. Calder, Agnes Scott College
ILLINOIS	Chicago	†**Burnham A.S.*	8:00, 2nd Tue.	Chi. Acad. of Sci.	J. M. Showalter, 6200 Kenmore Ave.
	Geneva	**Fox Valley A.S.*	8:00, 1st Tue.	Geneva City Hall	Joseph Zoda, 501 S. 6th, St. Charles
	Joliet	†*Joliet A.S.*	8:00, 3rd Mon.	Jol. Township H.S.	Mrs. Robert L. Price, 403 Second Ave.
	Moline	†**Popular A.C.*	7:30, Wed.	Sky Ridge Obs.	Carl H. Gamble, 3201 Coaltown Rd.
INDIANA	Indianapolis	†*Indiana A.S.*	2:15, 1st Sun.	Riley Library	E. W. Johnson, 808 Peoples Bank Bldg.
KANSAS	Topeka	**Topeka A.A.S.*	7:30, 2nd Mon.	Topeka H.S.	Miss N. Utschen, 1607 Wayne Ave.
	Wichita	†**Wichita A.S.*	8:00, 1st Wed.	.....	Dollie Ratcliff, 801 Maple, 2-1822
KENTUCKY	Louisville	†*L'ville A.S.*	8:00, 1st Tue.	Univ. of Louisville	B. F. Kubaugh, 621 34th St.
	Owensboro	†**Owensboro A.C.*	8:00, 3rd Sat.	Public Library	Herman Batt, 1507 Hathaway St.
LOUISIANA	New Orleans	*A.S. of N.O.*	8:00, Last Wed.	Cunningham Obs.	Dr. J. Adair Lyon, 1210 Broadway
MAINE	Portland	†*A.S. of Maine*	8:00, 2nd Fri.	Private homes	H. Harris, 27 Victory Ave., S. Portland
MASSACHUSETTS	Cambridge	†**Bond A.C.*	8:15, 1st Thu.	Harvard Obs.	Miriam Dickey, Harvard Observatory
	Cambridge	†**A.T.M.s of Boston*	8:00, 2nd Thu.	Harvard Obs.	Frank M. Roe, 35 Pemberton St. (40)
	Springfield	†**S'field Stars*	8:00, 2nd Wed.	Private homes	F. D. Korkosz, Mus. Nat. Hist., 2-4317
	Worcester	†**Aldrich A.C.*	7:30, 1st, 3rd Tue.	Mus. Natural Hist.	Ralph A. Wright, 4 Mason St.
MICHIGAN	Ann Arbor	†**Ann Arbor A.A.A.*	7:30, 2nd Mon.	U. of Mich. Obs.	Stewart W. Taylor, 1106 Birk Ave.
	Battle Creek	†*B. C. A.A. Club*	8:00, 2nd Fri.	Kingman Museum	Mrs. W. V. Eichenlaub, 47 Everett St.
	Detroit	†**Detroit A.S.*	3:00, 2nd Sun.	Wayne U., State Hall	E. R. Phelps, Wayne University
	Detroit	†**N.W. Detroit A.S.*	8:00, 1st Tue.	Redford H. S.	John W. Broxholm, 21412 Pickford
	Kalamazoo	†*Kalamazoo A.A.A.*	8:00, Sat.	Private homes	Mrs. G. Negrevski, 2218 Amherst, 31482
	Lansing	†**Lansing A.A.*	8:00, 1st, 3rd Wed.	Technical H. S.	Mrs. T. A. Louden, 940 Bensch St. (14)
	Pontiac	†**Pontiac A.A.A.*	8:00, 2nd Thu.	Private homes	Mrs. M. Chircop, 147 Prospect St., 21455
MINNESOTA	Duluth	†**Darling A.C.*	8:00, 1st, 3rd Fri.	Darling Obs.	R. Schmidt, 1910 Hughitt, Superior, Wis.
	Minneapolis	*M'polis A.C.*	7:30, 1st, 3rd Wed.	Public Library	Mrs. M. S. Skahen, 500 Ridgewood Ave. (4)
	St. Paul	*St. Paul Tel. Club*	7:30, 2nd, 4th Wed.	Macalester Coll.	Estelle F. Pfremmer, 636 Grand Ave. (5)
MISSOURI	Kansas City	**A.A. & T.M.s*	8:00, 4th Sat.	Private homes	Reginald Miller, Merriam, Kans.
	St. Louis	*St. Louis A.A.S.*	8:00, Sat.	Private homes	A. M. Obrecht, 2913 Park Ave.
NEVADA	Reno	*A.S. of Nev.*	8:00, 4th Wed.	Univ. of Nevada	G. B. Blair, University of Nevada
NEW JERSEY	Jersey City	†*Revere Boys Club*	7:15, Mon., Tue.	Gregory Mem. Obs.	Enos F. Jones, 339 Wayne St.
	Teaneck	†*Bergen Co. A.S.*	8:30, 2nd Wed.	Obs., 107 Cranford Pl.	J. M. Stofan, 332 Herrick
NEW YORK	Buffalo	†**A.T.M.s & Observers*	7:30, 1st, 3rd Wed.	Mus. of Science	R. M. Missert, 29 Crosby Ave., Kenmore
	New York	**A.A.A.*	8:00, 1st Wed.	Amer. Mus. Nat. Hist.	G. V. Plachy, Hayden Plan., *En.* 2-8500
	New York	†*Junior A.C.*	7:30, 4th Fri.	Amer. Mus. Nat. Hist.	J. Rothschild, Hayden Plan., *En.* 2-8500
	Rochester	*Rochester A.C.*	8:00, Alt. Fri.	Rochester Museum	Mrs. R. Dakin, Bushnell's Basin, Pittsford
	Schenectady	†*S'tady A.C.*	8:00, 3rd Mon.	Schenectady Mus.	G. Staffa, 32 Front St.
	Wantagh	*Long Island A.S.*	8:00, Sat.	Private homes	A. R. Luechinger, Seaford Ave., 1571
N. CAROLINA	Greensboro	**Greensboro A.C.*	8:00, 1st Thu.	Woman's Coll., U.N.C.	Mrs. Edith Settan, 1030 W. Market St.
	Rocky Mount	*Hi-Y A.C.*	8:00, Tue.	YMCA	J. A. Harper, YMCA
	Winston-Salem	†**Forsyth A.S.*	7:30, Last Fri.	Private homes	Kenneth Shepherd, 1339 W. 4th St.
OHIO	Cincinnati	**Cin. A.A.*	8:00, 2nd Fri.	Cincinnati Obs.	T. R. Stoner, RR 8, Cin. 30, *Be.* 7937-R
	Cincinnati	**Cin. A.S.*	8:00, 3rd Wed.	5556 Raceview Ave.	A. Moore, Hopkins & Letitia Sts., Amelia
	Cleveland	†*Cleveland A.S.*	8:00, Fri.	Warner & Swasey Obs.	Mrs. S. K. Towson, Warner & Swasey Obs.
	Columbus	**Columbus A.S.*	8:00, Last Tue.	McMillin Obs.	J. A. Hynek, Ohio State Univ.
	Dayton	*A.T.M.s of Dayton*	3rd Sat. Eve.	Private homes	F. E. Sutter, RR 7, Bx. 253A (9)
	Warren	†*Mahoning Val. A.S.*	8:00, Thu.	Private homes	S. A. Hoynos, 1574 Sheridan, NE, 25034
	Youngstown	**Y'town A.C.*	7:30, 1st Fri.	Homestead Pk. Pav'n.	F. W. Hartenstein, 905 Brentwood
OREGON	Portland	†**Portland A.S.*	7:00, 1st Wed.	Central Pub. Lib.	H. J. Carruthers, 427 S. E. 61 Ave.
	Portland	†*A.T.M. & Observers*	8:00, 2nd Tue.	Private homes	N. C. Smale, 831 N. Watts St.
PENNSYLVANIA	Beaver	†**Beaver Co. A.A.A.*	8:00, 4th Tue.	Com'y Bldg., Tamaqui	Mrs. R. T. LuCaric, Box 463, Baden
	Philadelphia	†*A.A. of F.I.*	8:00, 3rd Fri.	Franklin Institute	Edwin F. Bailey, *Rit.* 3050
	Philadelphia	**Rittenhouse A.S.*	8:00, 2nd Fri.	Morgan Physics, U.Pa.	Sarah Lippincott, Sproul Obs., Swarthmore
	Pittsburgh	†**A.A.A. of P'burgh*	8:00, 2nd Fri.	Buhl Planetarium	Charles H. LeRoy, R.D. 2 (15)
RHODE ISLAND	Providence	*Skyscrapers, Inc.*	8:00, Mon. or Wed.	Ladd Observatory	Ladd Obs., Brown U., *Ga.* 1633
S. CAROLINA	Columbia	*North'n Cross A.S.*	8:15, Every Mon.	Melton Observatory	Dr. L. V. Robinson, Univ. of S. C.
TENNESSEE	Chattanooga	**Barnard A.S.*	8:00, 2nd Fri.	Jones Observatory	C. T. Jones, 302 James Bldg., 7-1936
	Nashville	**Barnard A.S.*	7:30, 2nd Thu.	Vanderbilt Univ.	Miss J. Saffer, 446 Humphrey St. (10)
TEXAS	Houston	*Houston A.S.*	7:30, Last Fri.	Mus. Nat. Hist. Annex	Mrs. J. Murray, 1007 W. Gray (6)
UTAH	Salt Lake City	*A.S. of Utah*	8:00, 2nd Fri.	City and County Bldg.	Junius J. Hayes, 1148 East 1 S.
VERMONT	Springfield	†*Springfield T.M.'s*	6:00, 1st Sat.	Stellafane	John W. Lovely, 27 Pearl St., 535-W
VIRGINIA	Norfolk	†**A.A.S. of Norfolk*	8:00, 2nd, 4th Thu.	Museum of Arts	A. Hustead, U.S. Weather Bureau, 21745
WASHINGTON	Tacoma	*Tacoma A.A.*	8:00, 1st Mon.	Coll. of Puget Sd.	Dorothy E. Nicholson, 2816 N. Union Ave.
	Yakima	†**Yak. Am. Ast'mers*	8:00, 2nd Mon.	Cha. of Comm. Bldg.	Edward J. Newman, 324 W. Yakima Ave.
WISCONSIN	Madison	†*Madison A.S.*	8:00, 2nd Wed.	Washburn Obs.	Dr. C. M. Huffer, Washburn Obs.
	Milwaukee	†**Milw. A.S.*	8:00, 2nd Mon.	Public Museum	E. A. Halbach, 2971 S. 52 St., W. Allis
CANADA	Montreal	*RASC, Montreal*	8:00, Every Sat.	4052 Wilson Ave.	DeLisle Garneau, *Dexter* 1802

Just Published —

a book of exceptional interest to amateur astronomers . . .

SKYSHOOTING

Hunting the Stars with Your Camera

By R. Newton Mayall, Consulting Engineer, and Margaret L. Mayall, Harvard College Observatory

THERE IS a world of information, pleasure, and inspiration for amateur astronomers in this exciting new book. Based on the authors' own experience as skyshooters, it tells explicitly and understandably what there is in the heavens to photograph — the mysterious and beautiful aurorae, the flashing meteors, the uncountable stars, the majestic clusters and nebulae, our sister planets, the moon and sun — and how to shoot them.

There is also ample background material on astronomy, telescopes, telescope mountings, and other necessary or desirable equipment. Here, in short, is what any one needs to know to get properly started as a skyshooter, with reasonable certainty of success. And that camera skyshooters can produce astronomical pictures of great beauty is abundantly proved by the book's illustrations, all but four of which were made by nonprofessionals. **59 illustrations. $3.75.**

— and here is another excellent, widely read work

Sunspots in Action

By **DR. HARLAN TRUE STETSON.** A scientist of international reputation explains how explosions on the sun's surface affect our life on earth. In highly readable style he presents relevant information from several branches of science to analyze evidence we already have, and to appraise the more interesting theories that have recently arisen regarding sunspots. The book discusses the possible influence of sunspots on radio, television, the weather, plants and animals, and even the economic cycle. **"I have greatly enjoyed reading Dr. Stetson's book . . . presenting the subject interestingly and authoritatively in a way that is sufficiently nontechnical for the general reader."** — Dr. Donald H. Menzel, Harvard College Observatory. **Illustrated. $3.50**

MAIL TODAY

The Ronald Press Company
15 East 26th Street, New York 10

Send me the books checked. Within 5 days I will either remit full price, plus mailing charge, or return the books. **(We pay mailing cost if check accompanies order.)**

☐ Skyshooting, **Mayall-Mayall** **$3.75**
☐ Sunspots in Action, **Stetson** **3.50**
☐ Send me free folder describing full list of science books.

Name .....
Business .....
Address .....
City ..... Zone... State .....

M66

BOOKS AND THE SKY

SCIENCE, SERVANT OF MAN

I. Bernard Cohen. Little, Brown and Company, 1948. 362 pages. $4.00.

ONE OF THE MOST significant problems which confronts science and the scientist today is that of presenting to the layman an undistorted view of the ways by which scientific progress is achieved and an understanding of both the differences and interrelationships between science and technology — that is, between "pure" and "applied" science. The problem is acute because in a democratic country the layman is constantly called upon to make judgments which may profoundly affect the future of scientific investigation and consequently the future course of human history. It is imperative that these judgments be made in the light of an appreciative understanding of the nature, potentialities, and limitations of science. This is the problem which the author of this book has set out to attack, hence the subtitle, "A Layman's Primer for the Age of Science." However, the fact that the book is directed towards the layman does not mean that the professional or amateur scientist will not find it both interesting and profitable. There is much of value in it for all.

The book consists essentially of three parts. The first points out both the problem and its significance; the second consists of a series of case histories carefully chosen to illustrate the nature of scientific progress, the way in which it has been achieved, and its significance to modern life; the third sums up the material presented, and sets forth Dr. Cohen's conclusions and his suggestions for the future.

The initial premise of the book, as already stated, is that in our modern world, particularly in a democracy, it is a necessity for the citizenry to achieve some measure of understanding of science. Nobody presumes to ask the layman to acquire a vast store of technical knowledge, and it is extremely doubtful if this would satisfy the need for an understanding of science as a whole. However, in Dr. Cohen's words, "Nevertheless we must ask of the layman that he acquaint himself with certain broad principles of scientific development; that he learn under precisely what conditions important scientific discoveries are made, and in just what way the practical applications of science come about." This, the author feels, is to be achieved by inculcating an appreciative understanding for the "tactics and strategy of science" by the case history method so strongly advocated by President James B. Conant of Harvard.

Before proceeding to case histories, Dr. Cohen endeavors to show the conditions necessary for scientific discovery. This is the most important section of the book. It shows very clearly how individual scientific discoveries depend for their interpretation and development on the "total scientific situation." The "happy accident" may often occur, but the right man must be present and the scientific situation right for its exploitation. Thus X-rays were discovered through their action on a photographic plate, but the discovery of this effect could not have been made before the development of photography. Further, the fact that photographic plates were fogged in the vicinity of Crookes tubes was known before the discovery of X-rays, but the unimaginative conclusion was reached that the plates should be stored elsewhere. "Accidental" discoveries are shown to depend on many other less romantic factors. As Pasteur has said, "In the realm of observation, chance favors only the prepared mind."

Dr. Cohen wisely avoids an extended discussion of the definition of science, but goes on to present his views on the equally controversial subject of the scope of scientific activity. Following Dr. Conant, he likens this to a spectrum with pure science at one end and applied science at the other, and distinguishes the two ends of the spectrum by their goals — knowledge for the sake of knowledge, and knowledge for the sake of control or power. By immediately pointing out that he considers the spectrum to be a continuous one, he steers a middle course between the views of those who would completely separate pure and applied

A NEW SERVICE

24 35-mm. astronomical slides—10 chart slides —14 Mt. Wilson pictures—in sturdy glass mountings ..... postpaid $8.50 per set

ASTRONOMY CHARTS

The set of 25 charts, 8½ x 11, punched for looseleaf folders ..... postpaid $3.00
Single Wall Charts 27 x 35 inches (duplicates of the small charts) ..... each $3.00

Circular? Drop us a card.

ASTRONOMY CHARTED

4 Mason Street, Worcester 2, Mass.

WE REPAIR

★ *Microscopes* ★ *Telescopes*
★ *Field Glasses* ★ *Binoculars*

WE BUY, SELL, EXCHANGE OPTICAL AND SCIENTIFIC INSTRUMENTS

WAELDIN **10 Maiden Lane New York City BEekman 3-5393**

THE OBSERVATORY

A Magazine for Everybody Interested in Astronomy

Founded 1877

Current developments in astronomy illustrated by means of articles, correspondence, notes on discoveries. Reports of the meetings of the Royal Astronomical Society of London; the Darwin and Halley lectures.

Single copies, 60 cents
Annual subscription for 6 issues, postage paid, $3.00 to:

The Editors, Royal Observatory
Greenwich, London, S. E. 10, England

science and those who would fail to make any distinction. In the latter part of the book and also in the case histories, he demonstrates the dependence of all the "colors" of the scientific spectrum on one another, and shows the utter folly of those who criticize scientists for not planning all their work so as to promote the greatest human welfare.

Throughout the book is stressed the theme that pure research leads to practical applications, and pure research is not amenable to "planning." This cannot be too strongly emphasized because it brings out the vital fact that science is affected by other human interests.

Among the case histories, the astronomer will particularly enjoy the chapter on "The Solar Corona and Radio Communication." Other case histories cover the range of science from electric current and radio to the story of hybrid corn, and from synthetic rubber and nylon to the practical applications that came out of the study of plant hormones.

In the latter part of the book there is a discussion of the relation between science and warfare. The author strongly takes to task those who blame science for the evils of our present world. He points out that "Science is never an **immoral** activity, but rather **amoral** — completely removed from the moral sphere." As the "servant of man" it extends his powers and his desires, it does not presume to act as his moral preceptor, nor can it by its very nature.

The volume ends on a positive note. To the lay administrator of science, and indirectly this means to the citizenry as a whole, Dr. Cohen supports a plan which will:

1. Provide an educational system that offers equality of opportunity.
2. Find the superior men among those given this opportunity.
3. Give these men every advantage and facility possible.
4. Be certain that there are many rival and independent groups.
5. Beware in times of peace of co-ordinating agencies with dictatorial powers.

With our future as citizens at stake it is hoped that the readers of this book will concur.

JOHN W. ABRAMS
Ottawa, Ontario

NEW BOOKS RECEIVED

TABLES OF SINES AND COSINES TO FIFTEEN DECIMAL PLACES AT HUNDREDTHS OF A DEGREE, National Bureau of Standards, 1949, *Superintendent of Documents*, Washington 25, D. C. 95 pages. 40 cents.

This publication, No. 5 in the Applied Mathematics Series of the Bureau of Standards, gives sine and cosine functions in adjacent columns. With the argument to hundredths of a degree and the tables to 15 places, the book is designed to be of value to workers in observational astronomy, geodesy, navigation, optical instrument design, ballistics, rocket research, radar, and aircraft design.

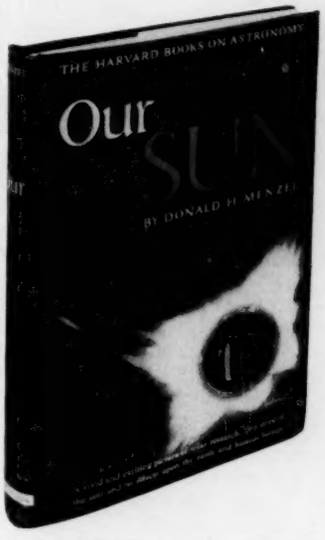
NAVIGATION THE EASY WAY, *Lane* and *Montgomery*, 1949, *Norton*. 126 pages. $2.95.

A simple book outlining the fundamental principles of navigation, piloting, dead reckoning, and celestial, with numerous diagrams, and designed so anyone who "knows how to read, add and subtract can learn to navigate."

JUST PUBLISHED! **MENZEL "Our Sun"**

A dramatic and entertaining book explaining the basic methods for finding out about the sun. It evaluates and discusses the sun as it affects our natural resources, as a possible source of power, heat and fuel, as it affects radio and weather forecasting; and lastly it explains the correlation between sunspots and the stock market. Certain to become a best seller, Our Sun is a book you can't afford to miss.

178 Illustrations. 326 Pages. $4.50



Have you read these Harvard Books on Astronomy?

Telescopes and Accessories by Dimitroff and Baker — **Earth, Moon and Planets** by Whipple — **Between the Planets** by Watson — **The Story of Variable Stars** by Campbell and Jacchia — **Atoms, Stars and Nebulae** by Goldberg and Aller — **The Milky Way** by Bok and Bok — **Galaxies** by Shapley — (All edited by Harlow Shapley and Bart J. Bok.)

Order from your bookstore or direct.

THE BLAKISTON COMPANY
1012 WALNUT STREET
PHILADELPHIA 5, PENNA.

Making Your Own Telescope — **The Nature of Cosmic Rays**
Atlas of the Heavens — **Sky and Telescope**

Sky Publications

Mappa Coelestis Nova — **Splendors of the Sky**
Relativity and Its Astronomical Implications — **Moon Sets**

MAKING YOUR OWN TELESCOPE, by Allyn J. Thompson, tells the complete story of how to make and mount a 6-inch reflecting telescope, at very low total cost. Excellent for use by telescope making groups. 211 pages, 104 illustrations. **$3.50**; foreign postage 40 cents

THE NATURE OF COSMIC RAYS, by W. F. G. Swann, gives a review of the fundamental physical and atomic principles involved in the study of this most powerful of all cosmic energies. 32 pages. **50 cents**

ATLAS OF THE HEAVENS, by Antonin Becvar and associates at the Skalnate Pleso Observatory. Sixteen charts cover the entire sky to magnitude 7.75, including doubles, multiples, variables, novae; galactic star clusters, globulars, and planetaries; 1950 co-ordinates. Each chart area is 15½ by 23½ inches. **$5.00**

SKY AND TELESCOPE may be sent as a gift; if requested, a donor's card is sent to the recipient of each gift subscription.

MAPPA COELESTIS NOVA, by Josef Klepesta, is a large wall chart, colorful as well as informative. The northern sky to —45° is shown on a polar projection, and each star is colored according to its spectral class. The chart makes a fine transparency, 28 inches square. **$3.50**

SPLENDORS OF THE SKY is a bargain in astronomical photographs, with explanatory captions, now in its third printing for a total of 36,000 copies in eight years. 36 pages, each 8½ x 11½ inches. **35 cents**, plus 5 cents postage

RELATIVITY AND ITS ASTRONOMICAL IMPLICATIONS, by Philipp Frank, is an outstanding explanation of the general theory of relativity, in language suitable for the layman. 24 pages. **50 cents**

MOON SETS are 18 full-sized plates, nine for the first-quarter moon and nine for the last quarter, from Lick Observatory negatives. Each plate is on a sheet of heavy stock 12 by 18 inches, and there are key charts for named lunar features. **$2.00**

All prices are postpaid except as otherwise noted. Order from your favorite bookstore, from the Adler, Buhl, Fels, Griffith, Hayden, or Morehead Planetarium (see Planetarium Notes for addresses), or write us directly. Payment should accompany all mail orders.

SKY PUBLISHING CORPORATION
HARVARD COLLEGE OBSERVATORY, CAMBRIDGE 38, MASS.

PRISM

In mounting of aluminum-magnesium alloy. Meets most exacting requirements. 1" by 1" face. Suitable as diagonal for reflectors, also as star diagonal on refractors. $3.00

INFRARED FILTERS

Complete in mounts, ready to snap on the objective of any standard 7 x 50 or 6 x 30 binocular. Photo #88. Extremely interesting photographic possibilities. All light operated electronic relay problems solved with this filter. Make your own "Sniperscope" from filters originally made by government for this purpose. Very finest optical glass mounted as shown. Set $1.00

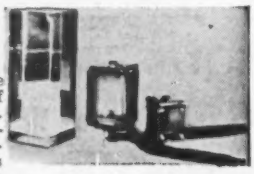
Variable Density Filter

Genuine Polaroid variable density device. 2¾" diameter. Complete new stock. Suitable for viewing the moon and the sun. Postpaid, $2.35

POLAROID

Experiment with polarized light. Receive two pieces of 2" by 2" genuine polaroid film that can be used in photography, petrology, physics, astronomy, and chemistry. Postpaid $1.00 Mounted in optical glass, 3" diameter (72 mm.) $1.25 each, 2 for $2.00. Also 1" (25 mm.) 60c, 2 for $1.00

PRISMS



Water - white crown glass of excellent quality. Government inspected and accepted. No chips or roughs. 45-90-45 degrees in mounts. Sizes:

⅞" x ⅞" (23 mm.) .....@ .75
1⅝" x 1-3/16" .....@ $1.50

Back silvered unmounted, size:
4" (102 mm.) x 1½" (39 mm.) ..@ $3.00

Front Aluminized Mirror

Finest quality plate ground to ¼ wave flatness and aluminized with a hard, almost scratch-proof coating. Nothing finer for use as a diagonal in place of prism. These "Flats" can also be used to reflect ultraviolet and infra-red light with minimum loss. Great saving if used in place of prisms in Porro #2 system.
Size 2⅜" by 3¼", $2.00

TELESCOPES

Popular Amer. makes. Can be used as finder.
5X Telescope .. $2.00 8X Telescope .. $7.50

Include Postage - Remit with Order

Send 50c for Up-to-the-minute Catalog

HARRY ROSS

TELESCOPES - MICROSCOPES
Scientific and Laboratory Apparatus
74 West Broadway, New York 7, N. Y.

GLEANINGS FOR ATM's

EDITED BY EARLE B. BROWN

SPECIFICATIONS FOR A BEGINNER'S TELESCOPE

THE DESIGN of the beginner's telescope made and assembled by the Junior Astronomy Club of Cleveland (see page 282) was based on that for an 8-power astronomical telescope described in a booklet, "What to Make with Chipped Lenses," published by the Edmund Salvage Company. With a telescope assembled from a $1.00 kit of 10 chipped lenses, we could see the craters on the moon, the four moons of Jupiter, and about 20 stars in the Pleiades. Of course, with simple lenses there are some "rainbows." We decided to make up kits of the other parts necessary and to use this design with a few modifications.

Lenses. The 8-power telescope uses three lenses: an objective 44 millimeters in diameter and of 393 millimeters focal length; a field lens, 33 by 221 millimeters; and an eye lens, 17 by 50 millimeters. Separately, these three lenses cost less than half a dollar, but school science teachers felt that students would learn more about optics if given a chance to experiment with other types of lenses. So we use the full kit of 10 lenses. The chipped edges do not usually show beyond the mountings and do not interfere with telescope optical quality.

Telescope Tubes. Mailing tubes are used instead of metal tubes because of low cost and ease of fabrication. But paper mailing tubes need to be reinforced at the ends by outer metal rings to resist crushing. We use aluminum, but any non-rusting tubing will do. The inside diameter of the mailing tube should be slightly larger than the diameter of the lens it contains. The outside diameter of the tube depends on the size of metal tubing used for the rings.

First we asked a mailing tube company to make an overrun on sizes near to our specifications. Later the company offered to make them to exact size at cost of direct labor and material — five cents for each pair of tubes in lots of 100 or more. We furnished samples of the two sizes of aluminum tubing that we use for reinforcing. The outer mailing tube was made a tight push fit to the outside metal rings. The inner tube was made a sliding fit to the 3" draw-tube bearing ring.

The objective lens is 44 millimeters in diameter, so we set 1¾" as the inside diameter of the **outer tube**. The nearest larger stock size aluminum tubing is 2" or 2¼". We use 2¼" O.D., 0.065" wall aluminum tubing, which gives us about 3/16" wall thickness of the paper tube. This sets the outside diameter of the outer tube at approximately 2⅛". For inner lens spacer rings and the draw-tube bearing we use 1¾" O.D., 0.065" aluminum tubing.

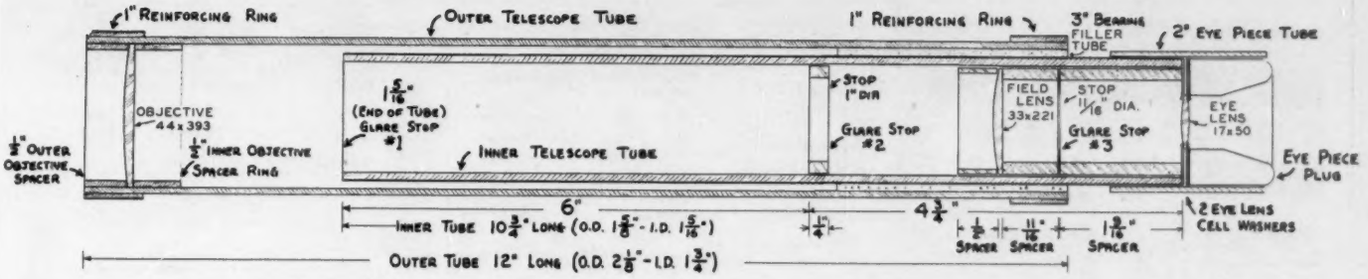
The field lens diameter of 33 millimeters sets the inside diameter of the **inner tube** at 1 5/16"; outside diameter a scant 1⅝" to make a sliding fit inside the 1¾" aluminum tubing.

Mailing tubes are made as a continuous operation by wrapping several plies of paper strips around a metal mandril. The inside diameter of the tubing is very close to the size of the mandril (diameters range by 1/16" steps). Outside diameters may vary because of variations in the thickness of the paper plies. In case of doubt, order the outside diameter slightly smaller, rather than too large. You can always increase the diameter by wrapping the paper tube with gummed tape to fit the metal reinforcing rings.

Metal Tubing. It was our hope to find industrial firms who would sell us their butt ends or cutoffs of aluminum tubing at scrap prices. But no local manufacturer used the sizes we had selected, so we had to buy new tubing in 12-foot lengths. By ordering in 25-pound lots we get a break

RINGS FOR OUTER TELESCOPE TUBE
2 OBJECTIVE CELL SPACERS
MATERIAL: 1¾" O.D. ALUMINUM TUBING (.065" WALL)
1 SMOOTH ENDS (RUB ON EMERY CLOTH) REMOVE BURRS AND ROUND ENDS USE: FILE - STEEL WOOL
2 IN ONE RING DRILL TWO HOLES ⅛" DIA. 180° APART (TO REMOVE OBJECTIVE LENS) USE: DRILL PRESS
3 WRAP O.D. OF BOTH RINGS WITH GUMMED TAPE - (PUSH FIT IN OUTER TELESCOPE TUBE)
4 PAINT INSIDE - FLAT BLACK PAINT
1 DRAW TUBE BEARING
MATERIAL: 1¾" O.D. ALUMINUM TUBING (.065 WALL)
1 SMOOTH - BURR - ROUND (SEE 1 ABOVE)
2 WRAP WITH GUMMED TAPE (SEE 3 ABOVE) (DO NOT PAINT)
3"
2 OUTER REINFORCING RINGS
MATERIAL: 2¼" O.D. ALUMINUM TUBING (.065 WALL)
1 SMOOTH - BURR - ROUND (SEE 1 2 TOP)
2 POLISH OUTSIDE (FOR LOOKS) USE: RAG WHEEL - POLISHING COMPOUND ON DRILL PRESS (DO NOT PAINT)
RINGS FOR INNER TELESCOPE TUBE
GLARE STOP #2 (1" HOLE)
MATERIAL: 1¾" O.D. BAKELITE TUBING (⅛" WALL)
1 SMOOTH ENDS (RUB ON EMERY CLOTH) REMOVE BURRS AND ROUND ENDS USE: FILE - STEEL WOOL
2 WRAP O.D. WITH GUMMED TAPE TO 1⅝" (PUSH FIT IN INNER TELESCOPE TUBE)
3 PAINT INSIDE & ENDS (FLAT BLACK PAINT)
3 FIELD AND EYE LENS SPACERS
MATERIAL: 1¾" PLASTIC OR 1¾" BAKELITE TUBING
1 SMOOTH - BURR (SEE 1 ABOVE)
2 PAINT INSIDE AND ENDS USE: FLAT BLACK PAINT
IF 1¾" TUBE - ASSEMBLE (11/16" - GLARE STOP #3 - 1⅛") AS UNIT
3 WRAP O.D. WITH GUMMED TAPE TO 1⅝" (SLIDE FIT INSIDE INNER TELESCOPE TUBE)
EYE PIECE OUTER TUBE
MATERIAL: 1¾" O.D. ALUMINUM TUBING (.065 WALL).
1 SMOOTH - BURR - ROUND ENDS (SEE 1 2 TOP)
2 POLISH OUTSIDE (FOR LOOKS) USE: RAG WHEEL - POLISHING COMPOUND ON DRILL PRESS (DO NOT PAINT)
2"

Two of the seven charts that are used as guides by members of the beginner's telescope group of the Junior Astronomy Club, drawn by Frank A. Myers.



The plan and dimensions for the telescope. Details of the parts assembly are shown in the seven guide charts.

in price; our cost of metal tubing is 20 cents per telescope for new tubing.

Plastic Tubing. Plastic tubing costs less than metal and can be used for the inner telescope tube spacers. One manufacturer had an overrun of 1 5/16" O.D. plastic tube of 1/16" wall thickness. This cost 77 cents per pound or one cent per inch. We use this for the spacer in front of the field lens, since this has to be a tight fit. For the other two spacers we found some 1¼" O.D., ⅛" wall bakelite tubing in a salvage store at 40 cents per 36" length. This is used for the spacers between the field and eye lenses and is wrapped with gummed tape to a slide fit inside the inner mailing tube.

Eyepiece Plug. Wood cores from paper rolls or gummed tape rolls can be used for the eyepiece plug. We found the size 1½" O.D. by 1¼" thick was used by paper box manufacturers. They used to burn them, but now several plants save them for us, gratis.

Manufacturers of insulating conduit bushings use various sizes of plastic (bakelite) tubing in wall thickness from ¼" to ½". Two Cleveland plants used to burn their scrap and short ends. Now they, too, save this material for us. The larger diameters make good lens cells and glare stops for larger telescopes.

Eye Lens Cell. A sheet-metal contractor gave us a lot of scrap narrow-width strips of soft 0.020" aluminum sheet. Such dealers often have cutoffs that you can buy at scrap prices. Any soft non-rusting sheet metal is suitable for the eye lens cell. We have this sheared in strips 1¾" wide.

Glare Stop. Glare stop No. 2 requires a 1" hole. For this we use the 1¼" by 1" bakelite tubing cut ¼" wide. For glare stop No. 3 we found some 0.020" black bakelite sheeting in a salvage store a yard square for $1.00 per sheet. This is sheared into strips 1⅜" wide.

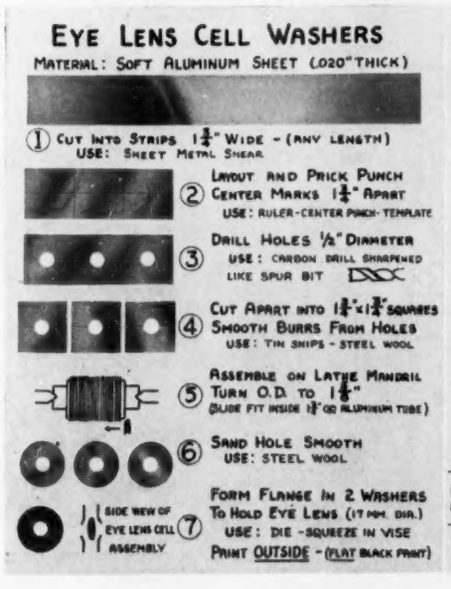
Covering Material. Bookbinderies use pyroxylin-coated (water-repellant finish) cloth for binding books. We use any dark color, preferably leather finish. We asked binderies to sell us their scrap, in pieces we could cut out to 6¾" by 10". Five bookbinders donated us enough cloth for about 500 telescopes, no charge. One company gave us 10 pounds of flexible bookbinders glue. Another lent us a thermostatically controlled electric glue pot for melting the glue to apply hot to the covering.

Gummed Tape. Kraft gummed tape of 60-pound weight in 2" or 3" rolls is used. We slice this down into ¼", ½", and ¾" widths. Several printers and paper merchants donated a supply.

Total Materials Cost. Our budget limit was $2.00 per telescope, but the actual cost for the first 100 kits was:

10 lenses (3 used in telescope)	$1.00
2 mailing tubes (2 sizes)	.05
6 aluminum tubes (2 sizes)	.20
2 glare stops	.01
3 plastic tubes (2 sizes)	.04
2 eye lens washers	.01
1 eye lens plug (no cost)	—
1 cloth covering (no cost)	—
Total cost	$1.31

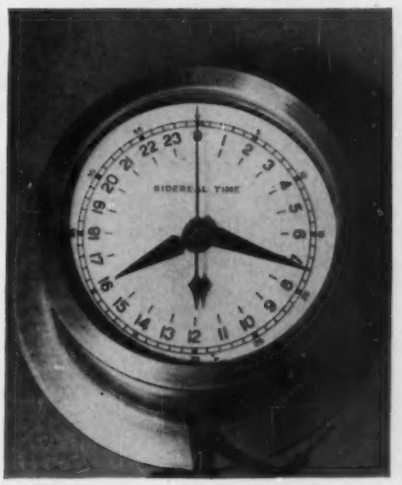
We figured that 19 cents per instrument would be enough to cover the cost of emery cloth, steel wool, paint, wood filler, gummed tape, and other supplies. So we charge $1.50 for the telescope kit of parts complete with 10 lenses. Of course, in a telescope making club neither the labor of the telescope maker nor of the instructor is figured in the cost of an instrument. Whenever we approached an


EYE LENS CELL WASHERS
MATERIAL: SOFT ALUMINUM SHEET (.020" THICK)
1 CUT INTO STRIPS 1 3/4" WIDE - (ANY LENGTH)
USE: SHEET METAL SHEAR
2 LAYOUT AND PRICK PUNCH CENTER MARKS 1 1/4" APART
USE: RULER-CENTER PUNCH-TEMPLATE
3 DRILL HOLES 1/2" DIAMETER
USE: CARBON DRILL SHARPENED LIKE SPUR BIT
4 CUT APART INTO 1 3/4" x 1 3/4" SQUARES
SMOOTH BURRS FROM HOLES
USE: TIN SNIPS - STEEL WOOL
5 ASSEMBLE ON LATHE MANDRIL
TURN O.D. TO 1 1/4"
(SLIDE FIT INSIDE 1 1/2" I.D. ALUMINUM TUBE)
6 SAND HOLE SMOOTH
USE: STEEL WOOL
7 FORM FLANGE IN 2 WASHERS TO HOLD EYE LENS (17 MM. DIA.)
USE: DIE - SQUEEZE IN VISE
PAINT OUTSIDE - (FLAT BLACK PAINT)
SIDE VIEW OF EYE LENS CELL ASSEMBLY

EYE PIECE PLUG - WOOD
RAW MATERIAL: WOOD PLUG FROM PAPER OR GUMMED TAPE ROLL
OPERATIONS:
1 DRILL 5/8" HOLE
USE: WOOD BIT IN DRILL PRESS
2 TAPER BORE ROUNDED END
USE: BURRING REAMER IN BRACE
3 ROUND TAPERED END
USE: FORM CUTTER IN DRILL PRESS
SAND ROUNDED END SMOOTH
4 WRAP 3/4" WIDE GUMMED TAPE AROUND OUTSIDE UNTIL O.D. IS 1 1/8" (USE STRIP "LONG)
5 PUSH FIT INTO 2" LONG TUBE
(FASTEN WITH GLUE)
FILL GAP WITH PLASTIC WOOD
PAINT END WITH BLACK LACQUER
2"

Coated Astronomical Objective
3⅛ inch by 50-inch focal length, air spaced, in black anodized duraluminum barrel.
• *Individually hand corrected and figured* •
Price $62.00
Dioptric Engineering Laboratories
47 West 56th St., New York 19, N. Y.

ELECTRIC SIDEREAL CLOCK

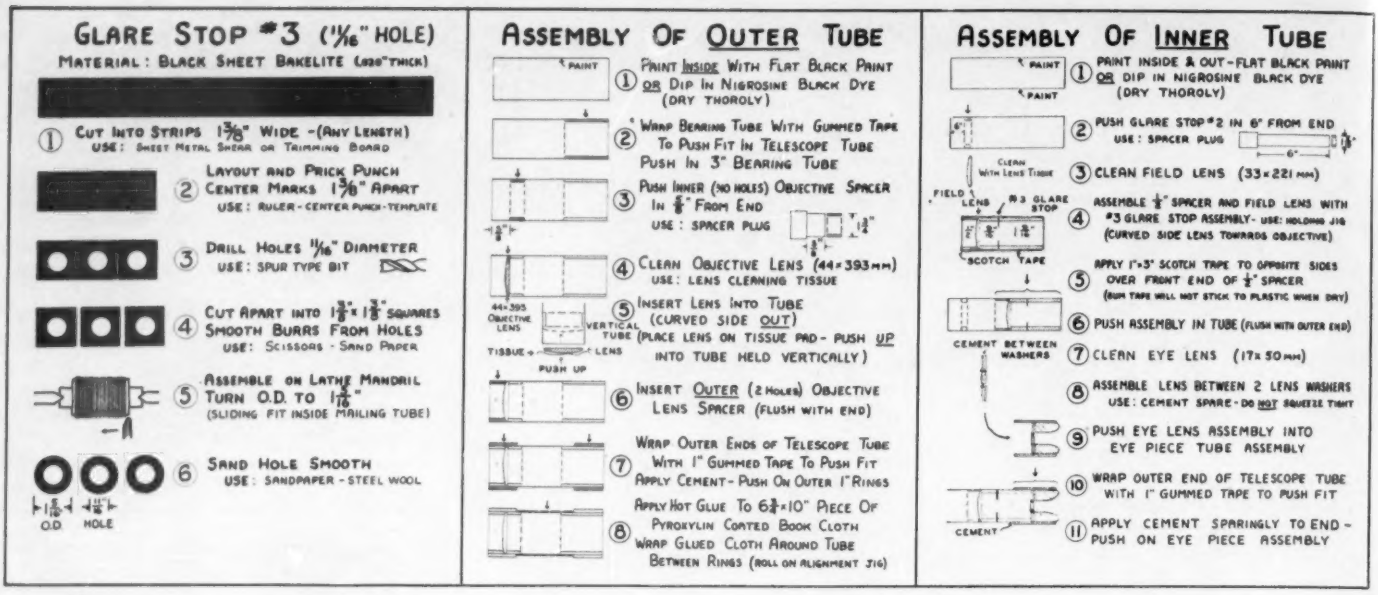


Sidereal time is required for the positive location and identification of celestial bodies visible or invisible to the naked eye.

This clock has gears that give a computed rating of less than six minutes slow in a century. Cast aluminum base, bronze front bezel, 4" minute circle, metal dial. Hands may be set from the front or back. 110 volts 60-cycle or 50-cycle on request. Good for all climates. **$36.00.**

Observers wishing to convert their standard clocks to sidereal may do so under our free instruction. The cost of gear changes is about $5.00. 24-hour dials may be had directly from John Stofan, 332 Herrick Ave., Teaneck, N. J., at a cost of $1.00 each.

Haines Scientific Instruments
Box 171, Englewood, New Jersey
Telephone: ENglewood 3-3441-J


GLARE STOP #3 (1/16" HOLE)
MATERIAL: BLACK SHEET BAKELITE (.030" THICK)
1 CUT INTO STRIPS 1 3/8" WIDE - (ANY LENGTH)
USE: SHEET METAL SHEAR OR TRIMMING BOARD
2 LAYOUT AND PRICK PUNCH CENTER MARKS 1 3/8" APART
USE: RULER - CENTER PUNCH - TEMPLATE
3 DRILL HOLES 1/16" DIAMETER
USE: SPUR TYPE BIT
4 CUT APART INTO 1 3/8" x 1 3/8" SQUARES SMOOTH BURRS FROM HOLES
USE: SCISSORS - SAND PAPER
5 ASSEMBLE ON LATHE MANDRIL TURN O.D. TO 1 1/16"
(SLIDING FIT INSIDE MAILING TUBE)
6 SAND HOLE SMOOTH
USE: SANDPAPER - STEEL WOOL
O.D
HOLE
ASSEMBLY OF OUTER TUBE
PAINT
1 PAINT INSIDE WITH FLAT BLACK PAINT OR DIP IN NIGROSINE BLACK DYE (DRY THOROLY)
2 WRAP BEARING TUBE WITH GUMMED TAPE TO PUSH FIT IN TELESCOPE TUBE
PUSH IN 3" BEARING TUBE
3 PUSH INNER (NO HOLES) OBJECTIVE SPACER IN 1/8" FROM END
USE: SPACER PLUG
4 CLEAN OBJECTIVE LENS (44 x 393 MM)
USE: LENS CLEANING TISSUE
44 x 393 OBJECTIVE LENS
VERTICAL TUBE
TISSUE
LENS
PUSH UP
5 INSERT LENS INTO TUBE (CURVED SIDE OUT)
(PLACE LENS ON TISSUE PAD - PUSH UP INTO TUBE HELD VERTICALLY)
6 INSERT OUTER (2 HOLES) OBJECTIVE LENS SPACER (FLUSH WITH END)
7 WRAP OUTER ENDS OF TELESCOPE TUBE WITH 1" GUMMED TAPE TO PUSH FIT
APPLY CEMENT - PUSH ON OUTER 1" RINGS
8 APPLY HOT GLUE TO 6 1/2 x 10" PIECE OF PYROXYLIN COATED BOOK CLOTH
WRAP GLUED CLOTH AROUND TUBE BETWEEN RINGS (ROLL ON ALIGNMENT JIG)
ASSEMBLY OF INNER TUBE
PAINT
PAINT
1 PAINT INSIDE & OUT - FLAT BLACK PAINT OR DIP IN NIGROSINE BLACK DYE (DRY THOROLY)
6"
2 PUSH GLARE STOP #2 IN 6" FROM END
USE: SPACER PLUG
6"
CLEAN WITH LENS TISSUE
FIELD LENS
#3 GLARE STOP
3 CLEAN FIELD LENS (33 x 221 MM)
4 ASSEMBLE 1/8" SPACER AND FIELD LENS WITH #3 GLARE STOP ASSEMBLY - USE: HOLDING JIG
(CURVED SIDE LENS TOWARDS OBJECTIVE)
SCOTCH TAPE
5 APPLY 1" x 3" SCOTCH TAPE TO OPPOSITE SIDES OVER FRONT END OF 1/8" SPACER
(SUN TAPE WILL NOT STICK TO PLASTIC WHEN DRY)
6 PUSH ASSEMBLY IN TUBE (FLUSH WITH OUTER END)
CEMENT BETWEEN WASHERS
7 CLEAN EYE LENS (17 x 50 MM)
8 ASSEMBLE LENS BETWEEN 2 LENS WASHERS
USE: CEMENT SPARE - DO NOT SQUEEZE TIGHT
9 PUSH EYE LENS ASSEMBLY INTO EYE PIECE TUBE ASSEMBLY
10 WRAP OUTER END OF TELESCOPE TUBE WITH 1" GUMMED TAPE TO PUSH FIT
CEMENT
11 APPLY CEMENT SPARINGLY TO END - PUSH ON EYE PIECE ASSEMBLY

industrial firm for scrap material, we explained our purpose: "We are trying to help school boys and girls make a telescope for less than two dollars. We are selling them the parts at cost, as a non-profit civic venture." We always offered to pay for scrap materials, but, as indicated by the foregoing, often did not have to do so.

The description of the beginner's telescope presented here is taken from a publication of the Cleveland Museum of Natural History, to be available in the fall of 1949 at a cost of one dollar a copy. Loose-leaf charts, 8½ by 11 inches, will be included, together with a detailed discussion of the step-by-step method of making each part. Power- and hand-tool operations will be described, and drawings are to be included of the jigs and fixtures used.

The writer's interest in telescope making started in 1945 with the assembly of war-surplus binoculars. In 1946 I made a 2½" spotting scope, and in 1947-48 a 4-inch astronomical telescope with an equatorial mounting. I have been interested in boy scout work since 1915, and have led various handicraft groups.

FRANK A. MYERS
Junior Astronomy Club
Cleveland Museum of Natural History
2717 Euclid Ave., Cleveland 15, Ohio

SKY-GAZERS EXCHANGE

Classified advertising costs 8 cents a word, including address; minimum charge $2.00 per ad. *Remittance must accompany order.* Insertion is guaranteed only on copy received by the first of the month preceding month of issue; otherwise, insertion will be made in next available issue. We cannot acknowledge classified ad orders. Write Ad Dept., Sky and Telescope, Harvard Observatory, Cambridge 38, Mass.

BUSCH BINOCULAR, pill box, coated optics, 80-mm. objective, 10x magnification. Mounted on sturdy adjustable tripod. Fine for observation and spotting purposes. Value $400.00 new, reconditioned price $250.00 complete. Send for our 8-page list of camera and projector bargains. All leading makes. Paul L. Brand & Son, 2153 K St. N. W., Washington 7, D. C.

A SUPER-DESIGN, coated achromatic f/3 Barlow lens to thrill you. Increases your scope's versatilities by lengthening at will your focal length to any practical magnification desired on each eyepiece with resultant better definition as natural to longer focal lengths. Comes with adapter tube which fits standard 1¼" eyepiece holders of refractors and reflectors. Users report seeing things never before seen with their scopes. Enables more comfortable use of highest powers with larger eye-end openings of low-power eyepieces. Gives beautiful flat field without spherical or color injection. Extends eyepieces only around 2" longer than normal. Resolves equally for all apertures and focal lengths. Money back after a week's trial if not astonished and delighted. No other Barlow with these ultra-modern super-design curves. Taken out of cell can fit in O.G. end of star diagonals. Only 14 left out of 134. Dozens will be disappointed by ordering too late. Send stamped return envelope for full information, otherwise included with order. Price $17.50 with adapter tube, test ring, and full directions. F. L. Goodwin, 345 W. Belden Ave., Chicago 14, Ill.

WANTED: 7" or 8" f/15 achromatic objective of professional make. G. W. Williams, 652 Colburn, Detroit 2, Mich.

FOR SALE: The telescope you have always wanted. 10" Newtonian reflector f/8, spring-motor drive, fork mounting, 180° reach. Several unique features, ideal instrument for a school. Complete with eyepieces, $450.00. Max Bartholomew, 13612 Kentucky, Detroit 4, Mich.

EVERYTHING in telescopes . . . from fine 4" completely equipped to inexpensive hand scopes suitable for the youngsters to experiment with. Lists free. Rasmussen and Reece, Amsterdam, N. Y.

SOUVENIRS from space. Iron-nickel meteorites found in Arizona. A novel gift for the student of astronomy. $3.75 to $35.00. Frederick Wendt, Troy, N. H.

4.5" REFRACTING TELESCOPE, f/15 objective. Made in Germany. Rack and pinion focus control, 12x finder with crosshair eyepieces. Alt-azimuth mount on tripod; tube is duraluminum. 3 celestial and 3 terrestrial eyepieces. $470.00. For details and photographs write John Weiss, 13725 Dexter, Detroit, Mich.

6" BRASHEAR OBJECTIVE (flint in front) for sale, brass tube, finder, 5 oculars, star and Herschel prisms. $750.00. A. Wade, 4139 Camero Ave., Los Angeles 27, Calif.

THE AMATEUR'S pal on a cloudy night. Show your friends the craters on the moon in a Lunascope — 50 cents. Valley View Observatory, Pittsburgh 14, Pa.

FOR SALE: 6", f/8 Newtonian reflector; well-built base and tube; slow motion crank; cost price — selling price — $95.00. Somers, 27 Lafayette Parkway, Rochester 10, N. Y.

FOR SALE: Mounted 4", 5", and 6" refractor objectives of first quality. $100.00, $200.00, and $300.00. Correspondence invited. Earl C. Witherspoon, Sumter, S. C.

FOR SALE: 6" pyrex aluminized telescope mirrors, 48" focal length. $25.00 each, sent postpaid. With each mirror you receive two free plastic setting circles. Write to William H. McDonough, 44 Linden St., Brookline 46, Mass., for further information.

PYREX MIRRORS of 4¼", 6", and 8" diameter made to order, unaluminized. $15.00, $27.00, $37.00, respectively. Paul Chorley, 143 Edgemont, Vallejo, Calif.

35-MM. CAMERA: Perfex 55 with f/2.8 Wollensak lens. In like-new condition; case and instructions. Cost new $100.00, first $50.00 takes it. Brand new 20x Davidson spotting scope and stand, coated lenses. Cost $27.25, sell for $18.00. John T. Hopf, 31 Kalbfus Rd., Newport, R. I.

FOR SALE: 6" aluminized parabolic mirror, focal length of 60", perfect figure. $30.00. James Bray, 860 Walnut Ave., Burlingame, Calif.

FOR SALE: One 8", f/8, parabolic pyrex mirror. Will have mirror BER-AL coated by Clausing and ship postpaid. Satisfaction guaranteed. $60.00. R. H. Kimball, 88 Maryland Ave., Pittsfield, Mass.

FOR SALE: 12" f/6.3 Newtonian reflector complete with cradle-type equatorial mount, 12-volt D.C. drives and power supply, fixed and portable controls, and photographic equipment for moon, planets, and star fields. Telescope gives excellent performance in stable atmosphere. Write W. Marsteller, 540 Buttonwood St., Norristown, Pa., for complete description and price.

ELECTRIC DRIVES with clutch and mounting bracket made to suit your telescope. $60.00 F.O.B. Inquiries invited. Fellows Engineering Works, Middle Haddam, Conn.

EVERYTHING FOR THE AMATEUR
TELESCOPE MAKER
KITS 6"—$5.50 up; Pyrex, 6" .... $7.50 up.
Other sizes in proportion.
ALUMINIZING
Superior Reflecting Surface, Fine Finish.
Will not Peel or Blister. Low Prices.
Mirrors Tested Free | Prisms Eyepieces Accessories | Send for Free Catalog
MONEY BACK GUARANTEE
Precision Optical Supply Co.
1001 E. 163rd St., New York 59, N. Y.

SAVE UP TO 50% THE WORLD'S Greatest VALUES in BINOCULARS
ZEISS TYPE. BRAND NEW. DELUXE LEATHER CASE INCLUDED. Built to rigid military specifications. Never before at these prices!
Fully Guaranteed. OFFER IS LIMITED
6 x 25 ..... $24.00 with Coated Optics $30.00
8 x 30 ..... 30.00 with Coated Optics 38.00
7 x 50 ..... 40.00 with Coated Optics 48.00
10 x 50 ..... 52.00 with Coated Optics 62.00
Many other models. Largest Stock in the West.
Add 20% Fed. Tax Postage Included
ORDER TODAY! Send check or money order; $2.00 Deposit on COD's. MONEY-BACK GUARANTEE! Free Booklet "HOW TO SELECT BINOCULARS"
SIX POWER Pocket Binocular
WITH DELUXE LEATHER CASE. LIGHT • COMPACT • TAKE IT EVERYWHERE - 6 x 15 with COATED OPTICS. Weighs only 4 ounces! Size: 2 x 3¼ inches. A high quality prism binocular (German design) with precision ground achromatic lenses. Field of view: 370 feet at 1000 yards.
MADE TO SELL FOR $39.95 ORDER TODAY! with Coated Optics $22.00
Only $18.00...
BUSHNELL IMPORTERS Dept-Y9 43 E. Green, Pasadena 1, Calif.

Complete Telescopes

Reflectors and Refractors suitable for universities and private use. All optical parts of the highest quality.

Ramsden Eyepieces

that have satisfied hundreds of buyers.

Equivalent focal lengths ¼", ⅓", ½", ¾", 1" ..... $5.15 each
1¼", 1½", 2" ..... 10.25 each
All standard 1¼" diameter; postpaid.

FINDERS that can be swung to either side of tube for convenience.

Send for free price list and description on complete Telescopes, Mountings, Combination Eyepiece and Prism Holders, Aluminum Mirror Cells, Star Diagonals, Prisms.

C. C. Young

25 Richard Road **East Hartford 8, Conn.**

ALUMINIZING

HARD BER-AL COATING

Our exclusive high-reflectivity BER-AL coatings are free from chromium and they are not overcoated with fluorides or quartz. They can be removed easily, when desired, without harm to the glass surface below. Prices for BER-AL coatings, f.o.b. Chicago, are: $2.50 for 6" diameter mirrors, $3.50 for 8", $5.00 for 10", and $8.00 for 12½". Larger sizes up to 24" diameter on request.

LEROY M. E. CLAUSING
4544 N. Western Ave. **Chicago 25, Ill.**

Weather Instruments

for amateur observers

THERMOMETERS
HYGROMETERS
BAROMETERS
WIND VANES
ANEMOMETERS
RAIN GAGES

We plan and supply complete weather stations for simple or elaborate requirements. Order from us all your meteorological books, maps, charts, and teaching aids. Send 10 cents in coin or stamps for Catalog S.

Everything for the study and practice of meteorology.

SCIENCE ASSOCIATES

401 North Broad Street, Philadelphia 8, Pa.

IN FOCUS

(Continued from page 270)

four feet in clear aperture, eight inches larger than the lens of the 40-inch Yerkes Observatory refractor. It is mounted at the center of curvature of the primary mirror. Midway between mirror and correcting plate is the focal plane; thus the focal ratio is 120/48, or f/2.5.

The plates of the Schmidt survey will each cover an area of 36 square degrees, with a ¾-inch margin for overlapping. The fields will have uniform definition and full illumination except in the four corners, where there will be a loss of about 1/20 magnitude, due to slight vignetting.

The plateholder and loading device, of ingenious design, show in a box in the drawing, below the upper fork. The observer inserts the loaded plateholder. After a switch is closed, the plateholder is drawn up to the focus by a cable, leaving the dark slide in the box, and the shutter is opened. During all of this the telescope may be driving on a particular field of the sky. After exposure, the operation is reversed.

The shutter for the 48-inch Schmidt, shown here in open position, is mounted inside the tube just below the correcting plate, not outside as in the case of Palomar's third principal instrument, an 18-inch Schmidt that has been in operation for many years.

On the west side of the polar axis, to the right in the drawing, is the control board, similar in design to that of the Hale reflector. By this array of switches and controls the telescope is easily pointed and accurately driven. Note the phantom telescope in the lower right-hand corner of the control board to limit the positioning of the instrument, and to keep the wind shield (shown partly raised in the drawing) and dome slot perfectly positioned with reference to the telescope tube (see **Sky and Telescope**, July, 1949, page 228).

The platform at the extreme right is used to gain access to the correcting plate. With the tube placed on the meridian in a horizontal position (shown by Dr. Porter in phantom outline), Palomar technicians can remove the correcting plate, clean it, or add objective prisms as required.

BINDERS

for SKY AND TELESCOPE

File each issue as it comes . . . a new type of binder holds a year's issues . . . opens flat for quick use of your magazines . . . dark blue fabrikoid with SKY AND TELESCOPE gold-stamped on cover and back . . . reuse from year to year or keep each volume permanently bound in this form . . . **$2.95** **postpaid**
($3.50 in Canada)

Orders accepted for delivery in the United States and Canada only. Payment must accompany your order.

If you wish, your name gold-stamped, 50 cents extra; volume number, 30 cents; both, 75 cents. Please print the desired lettering clearly.

SKY PUBLISHING CORPORATION
Harvard College Observatory
Cambridge 38, Mass.

WAR SURPLUS

BARGAINS!!

ACHROMATIC TELESCOPE OBJECTIVES—Perfect Magnesium-fluoride Coated and cemented Gov't. Surplus lenses made of finest Crown and Flint optical glass. They are fully corrected and have tremendous resolving power. Guaranteed well suited for Astronomical Telescopes, Spotting Scopes, etc. Gov't. cost approximately $100.

Diameter	Focal Length	Each
56 mm (2 3/16")	600 mm (23½")...	$12.50
76 mm (3")	381 mm (15").....	19.00
81 mm (3 3/16")	622 mm (24½")....	22.50
83 mm (3¼")	876 mm (34½")...	28.00
83 mm (3¼")	1016 mm (40")	30.00

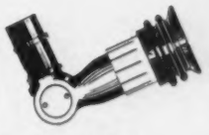
8 POWER FEATHERWEIGHT BINOCULARS—Small, compact (8 x 25 French, not surplus). All around sport glass; use for Races, Hunting, Bird Study, etc. Complete with carrying case and straps.
$60.00 Value **$29.75***
***plus $5.95 Excise tax — Total $35.70**

7 x 50 BINOCULARS—Brand new complete with carrying case and straps. Made in Occupied Japan. Satisfaction guaranteed. Comparative American binoculars are priced at $168.00 plus tax **$42.50***
***plus $8.50 Excise tax — Total $51.00**

7 x 50 BINOCULARS with Coated Lenses and Prisms **$52.50***
***plus $16.50 Excise tax — Total $63.00**

40 POWER TELESCOPE
Coated Lenses

Precision American Made Variable Power Telescope (not war surplus). FOUR TELESCOPES in One. 10X, 20X, 30X and 40X. Magnesium-fluoride Hard Coated lenses. Achromatic Objective lens 2⅛" (53 mm) dia. Length closed 9½", open 27½". Aluminum and brass construction throughout. Genuine Leather covering. Weight 28 ozs. **$42.50**



3X ELBOW TELESCOPE—Brand new; has 1" Achromatic Objective, Amici Prism Erecting System, 1⅜" Achromatic Eye and Field Lens. Small, compact, light weight, 2 lbs.
Gov't. Cost $200. **$6.50**

OPTICAL PEEP SIGHT—Use as camera view finder, etc. Image appears on bullseye reticle. Same principle commercially used by shotgun sight mfr. Dia. 37 mm. Weight 1½ ozs. Government cost $10.75.
Our price **$1.50**

27 POWER SPOTTING SCOPE LENS SET. This set of lenses will make a Spotting Scope comparable in optical quality with scopes priced at $75.00 to $100.00. REMEMBER the lenses are the heart of the instrument. Consists of big 56 mm (2 3/16") dia. Coated Objective Lens, 2 Prisms, Eyepiece Lenses. Instructions. All optics cemented and Perfect or near Perfect ..... Set **$16.75**

LENS CLEANING TISSUE—Here is a wonderful Gov't. Surplus buy of Lens Paper which was made to the highest Gov't. standards and specifications. 500 sheets size 7½" x 11". **$1.00**

RIGHT ANGLE PRISMS for photography or astronomical telescopes. The prisms have square faces, some can be supplied with silvering. Write for list "S."

8 mm Face	ea.	$ .75
23 mm Face	ea.	1.25
30 mm Face	ea.	1.75
38 mm Face	ea.	2.00
47 mm Face	ea.	3.00

Send 3c stamp for Big "Bargain" List

WE PAY THE POSTAGE
A. JAEGERS **93-08S 95 AVE. OZONE PARK 16, N. Y.**

Now! Saturn 3 Inch
PORTABLE REFRACTORS
Only $199.00

For the first time an instrument capable of serious astronomical research is available for less than $200.00! The Saturn 3 Inch Portable Refractors are precision made by the West's largest makers of observatory instruments; objective lenses are highest grade precision ground, achromatic f-15 crown and flint glass, all moving parts are precision machined.

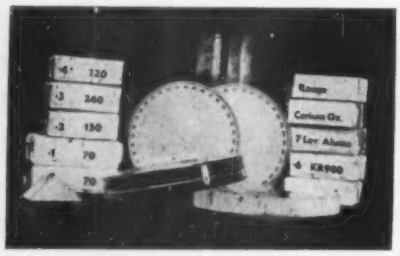
Although the Saturn 3 Inch Refractor has a 45 inch focal length, the instrument is easily portable, weighing less than thirty pounds, including tripod.

Saturn 4 Inch Portable Refractors from $345.00; larger instruments manufactured to order.

Write for literature giving full information on the Saturn Refractors.

Tinsley
2530 Grove Street
Berkeley, California

New Low Prices on PYREX Reflecting Telescope Kits



Two circle dials with every Pyrex Kit.

The most complete kits on the market. In addition to the usual supply of abrasives, rouge, etc., you get the new, fast-polishing cerium oxide to save hours of work. You can get a brass diagonal holder (spider) for only $1.00 additional if ordered with a telescope kit. Prices quoted below are for a Genuine Pyrex telescope blank and a plate glass tool.

PYREX MIRROR KITS

4"	$ 5.25	6"	$ 6.75
8"	9.75	10"	16.75
12½"	31.75	16"	65.00

4" to 16" PYREX CARRIED IN STOCK

PLATE GLASS KITS

6" x ¾"	$4.75	6" x 1"	$ 5.25
8" x 1"	7.25	9¾" x 1½"	12.50

Postage Paid to 1st and 2nd postal zones from N. Y. Add 5% 3rd and 4th zones, 10% 5th and 6th zones. Add 15% 7th and 8th zones.

Parabolic pyrex mirrors made to order.

Send for free catalog of optical supplies.

DAVID WILLIAM WOLF
334 Montgomery St. Brooklyn 25, N. Y.

OBSERVER'S PAGE

Universal time is used unless otherwise noted.

The Midwestern Fireball of July 22nd

AT ABOUT 8:05 p.m. CST on Friday, July 22nd, a huge fireball passed over northern Illinois and southern Wisconsin. The writer was not so fortunate as to witness its passing, nor in almost 15 years of observing meteors has he even seen a fireball. About three minutes after its passing, the telephone calls began pouring in. Appeals for information about the object were immediately telephoned to the newspapers and radio stations in Milwaukee and Chicago. Thanks to the assistance of Roy R. Lee, of the Milwaukee Astronomical Society, who became the recipient of all information, about 200 calls and almost an equal number of pieces of mail were received.

The weather was exceptionally clear over the central states so the meteor was seen over great distances. The most distant report came from a community in upper Michigan, 300 miles from the path. The time was early evening and no bright stars were visible to aid in position measurements, so the object can be classified as a daylight meteor.

Reports from fishermen were very common, but few were of value because of uncertain locations on lakes with respect to surrounding landmarks. No attempt was made to obtain more information by mail from those who witnessed the spectacle. From past experience, such appeals are of little value because few observers are trained in measures of angles. William Albrecht, of the MAS, and the writer made a trip to the southwestern part of Wisconsin on Sunday, July 24th, to interview witnesses. We were successful in making about a dozen useful measurements, and we returned home with sufficient information to indicate that the last outburst of light occurred at an elevation of about eight miles over the rolling hills near New Glarus, 20 miles southwest of Madison, Wis.

Professor Ralph Huffer, of Beloit College, reported: "All observers agreed that the meteor passed directly overhead. Others without exception saw it fall straight down—90-degree angle of descent. I heard some unexpected thunder about this time, inside the house, and I wondered what it was as I had seen no meteor."

The beginning of the meteor's path was approximately over the west shore of Lake Michigan, south of Waukegan, Ill. At the time of this writing, there are no reports from Chicago other than from a nine-year-old girl who said it was definitely south of the zenith as she observed it from a Chicago beach. Thus, with a very uncertain beginning point, it can only be stated that its direction was almost due northwest. Interviews with the various observers are to be continued in an effort to make a better determination of the meteor's path.

The duration of flight, based upon the many reports of untrained and a few trained observers, was three seconds. The length of the meteor's visible path was about 130 miles, which agrees quite well with an assumed velocity of 45 miles per second, a common figure used for meteor velocities.

The descriptions of the meteor were very similar in that its nucleus or head was about half the apparent size of the full moon although far more brilliant. It was followed by a tail described to be about three times longer and considerably broader than the head. Nearly everyone describes the sparks given off along its path; several reported a breakup of the main body into two parts near the end of its travel. A research laboratory assistant in Milwaukee, who could be classified as a trained observer, reported that after the last outburst a dull red small body was seen to continue in the same direction until it was lost from sight on the horizon. From all accounts it seems quite probable that the main body reached earth. The chances of its recovery are handicapped by the rugged terrain of the rolling hills in southwestern Wisconsin. Most of the land is under cultivation, corn predominating.

The writer is on his vacation at present so expects to be able to spend several days interviewing more people to determine the meteor's path and its possible resting place if it came to earth.

EDWARD A. HALBACH
Milwaukee Astronomical Society
2971 S. 52nd St., Milwaukee 14, Wis.

Constellation Pointers

Ideal for Star Parties

For the first time from war surplus, a Navy multipurpose signal light that makes a super pointer, with a 4½-inch beam. Easily held in hand, it is trigger operated. Has transformer for 110-volt line or works on 6 volts off car battery or dry cells. Complete with carrying case, spare bulbs and switches $8.95

PLASTIC TELESCOPE TUBES

Perfect for refractors and small reflectors; smooth bore 4½" inside diameter; ¼-inch wall thickness; weight only 2½ lbs. per foot. In 8-foot lengths only; easily cut to any length. 10% off in lots of 10 or more ..... each $5.00

Batteries for Photometers

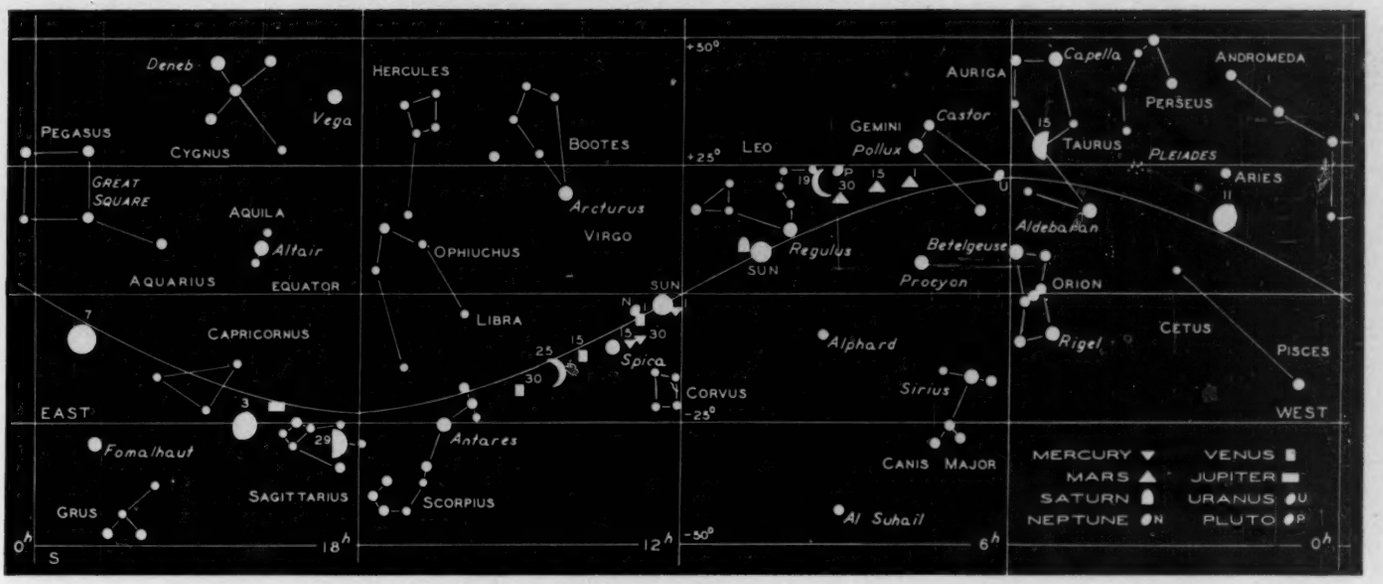
Recently tested and found perfect, for they are export wrapped. Standard Type BA-26, 22½-45-volt, each $1.00

OTHER SURPLUS ITEMS INCLUDE:

Plate Glass Disks 5¼" x ¾" ..... ea. $1.00
Defender Filters, 5" x 5", for lunar and planetary work, yellow or green ..... ea. .25
2" Mounted Mirrors, 5¼" f.1 ..... ea. $1.00
Universal Joints, ⅜" to 1" ..... ea. $5.00
Weather Balloons, 6 cu. ft. ..... ea. $1.00
SPECIAL: Weather station (used) with David White theodolite ..... $300.

All above prices plus shipping charges.

Write us or telephone PResident 3-7100
QUINCY-GROSSMAN SURPLUS COMPANY
130 Granite St., Quincy 69, Mass.



THE SUN, MOON, AND PLANETS THIS MONTH

The sun, on the ecliptic, is shown for the beginning and end of the month. The moon's symbols give its phase roughly, with the date marked alongside. Each planet is located for the middle of the month and for other dates shown.

Sun. On September 23rd, at 9h 06m UT, the sun arrives at the junction of the ecliptic and the celestial equator, traveling southward. Autumn commences in the Northern Hemisphere and spring in the Southern.

Mercury arrives at eastern elongation on September 7th, 27° from the sun. Nevertheless, for observers in northern latitudes, the planet will appear low in the west at sunset. The ecliptic attains maximum inclination at the equinoxes; therefore Mercury is nearly 13° in declination south of the sun. The setting time is less than one hour after sunset. For the tropics and the Southern Hemisphere, this is a very favorable elongation.

Venus, the brightest object in the sky excepting the sun and moon, is easily seen in the west after the sun sets. Its brightness slowly increases through the month, and on the 30th Venus shines at magnitude −3.6. The planet has then moved to about 40° east of the sun in longitude. Venus passes 2° north of Spica on September 8th.

Mars rises about four hours before the sun, far from a prominent object, of the 2nd magnitude. On the first days of this month, the ruddy planet forms a line with Castor and Pollux in Gemini, Mars being south of the stars. The rapid motion of Mars brings it to the boundary of Leo by early October.

Jupiter may be found in the southern sky at sunset, a brilliant object of magnitude −2. Direct or eastward motion resumes on the 18th, the planet remaining in eastern Sagittarius. In a telescope, the polar diameter is about 40″, roughly three times the apparent diameter of Venus.

Saturn enters the morning sky on September 2nd, passing conjunction with the sun. The inclination of the ecliptic is advantageous in this case, the reverse of the situation for Mercury in the evening sky. Therefore, by the 25th Saturn is well north of the sun, rising 1½ hours ahead of it.

Uranus comes to western quadrature with the sun on September 28th, and is thus observable the latter half of the night. On the 9th, the planet will be in conjunction with Mu Geminorum (+3.2), Uranus 1° 4′ north and three magnitudes fainter.

Neptune is too near the sun for favorable observation. E. O.

THE LUNAR ECLIPSE NEXT MONTH

ON OCTOBER 6-7, there will be a total eclipse of the moon, some characteristics of which are similar to the event of April 13th. The magnitude of the October eclipse will be 1.228, as compared with 1.432 in April. Therefore, with the moon penetrating not so far into the umbra of the earth's shadow, the eclipse may not be as dark as the one last spring. Another and more important difference influencing the darkness of the eclipse is that in April the moon was at perigee, whereas at eclipse time next month it will be practically at apogee.

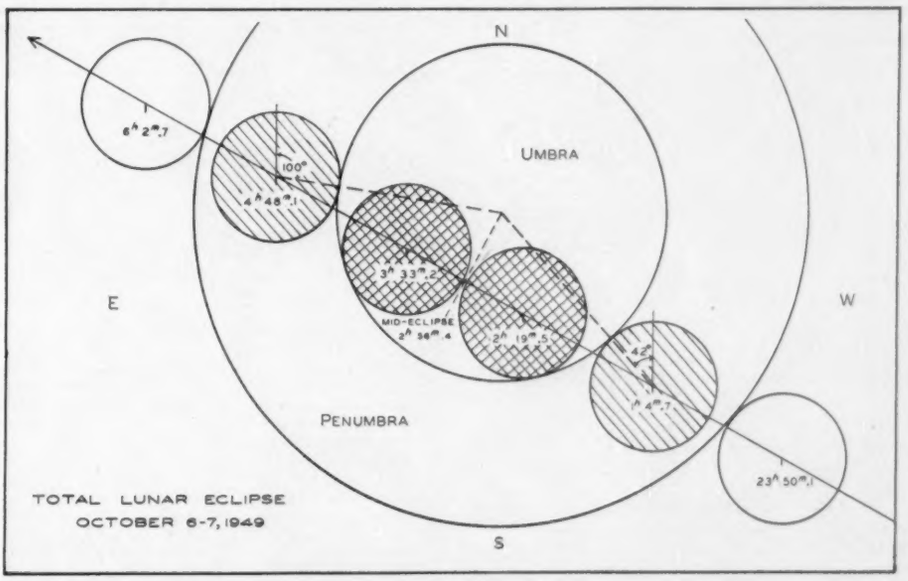
These eclipses are very favorable for American observers because they are scheduled for the early evening, but in October on the West Coast, with moonrise at about 5:30 p.m. local time, the umbral phase will start before the moon comes up. The accompanying diagram gives the times of the contacts, which in Pacific standard times are 5:04.7 p.m. for entrance into the umbra; 6:19.5 p.m. for beginning of totality; 7:33.2 p.m. for ending of totality; and 8:48.1 p.m. for leaving the umbra. On the East Coast, mid-totality occurs at 9:56.4 p.m. Eastern standard time.

The **American Ephemeris and Nautical Almanac** states that position angles of first and last contacts of the moon's limb and the umbra will be 42° to the east and 100° to the west, respectively.

MOON PHASES AND DISTANCE

Full moon	September 7,	9:59
Last quarter	September 15,	14:29
New moon	September 22,	12:21
First quarter	September 29,	4:18
Full moon	October 7,	2:52

	September		Distance	Diameter
Apogee	10d	11h	252,200 miles	29′ 26″
Perigee	23d	4h	222,400 miles	33′ 23″



REVOLVING OBSERVATORY DOMES

Electric Motor Driven
Diameter 10 Feet to 30 Feet

Track and skeleton framework. All parts without skin. From $750.00 to $2,500.00 F. O. B. Englewood, N. J.

Complete job from $1,500.00 to $5,000.00 and expenses of two men, or more.

MOUNTINGS

Mounts for your telescope are available in the following types:

Model No. 3. STUDENTS' WEATHERPROOF $270.00

Model No. 4. VARIABLE STAR INSTRUMENT $300.00

Model No. 5. TEACHERS' MODEL for Schools $345.00

Model No. 6. THE UNIVERSITY MODEL $550.00

For more detailed information on Haines equatorial mountings, see our advertisement in the July issue of Sky and Telescope.

NEW DESIGN OF SPRINGFIELD CASSEGRAIN mounting with no overhead counterweight and plenty of room for the knees and feet by offset column for most comfortable observing. Motor driven slow motions in both axes as well as synchronous sidereal drive on polar axis. Universal switch held in hand or pocket will move the telescope slowly to any part of the sky. 13" circles, 1440 divisions. REAL OBSERVATORY EQUIPMENT.

Monthly Payments

Haines Scientific Instruments

Box 171, Englewood, New Jersey
Telephone: ENglewood 3-3441-J

JUPITER'S SATELLITES

September 1, 4203; 1:35 I Tr, 2:32 I Sh, 3:52 I TrE, 4:49 I ShE. **2,** 40123; 2:06 I EcR. **3,** 41032; 6:49 III Tr. **4,** 3201; 2:06 IV Oc, 6:14 IV OcR. **5,** 31204; 8:14 II Oc. **6,** 30124; 8:57 I Tr, 9:59 I Sh. **7,** 1024; 0:53 III Ec, 3:06 II Tr, 4:29 III EcR, 5:09 II Sh, 5:52 II TrE, 6:13 I Oc, 7:56 II ShE, 9:32 I EcR. **8,** 20134; 3:24 I Tr, 4:28 I Sh, 5:41 I TrE, 6:45 I ShE. **9,** 0234; 0:40 I Oc, 2:30 II EcR, 4:01 I EcR. **10,** 10324; 0:09 I TrE, 1:14 I ShE.

September 11, 32014. **12,** 32104; 9:18 IV Tr. **13,** 34012; 0:17 IV ShE. **14,** 4102; 0:18 III Oc, 3:52 III OcR, 4:54 III Ec, 5:30 II Tr, 7:44 II Sh, 8:03 I Oc, 8:16 II TrE, 8:30 III EcR. **15,** 42013; 5:15 I Tr, 6:23 I Sh, 7:31 I TrE, 8:40 I ShE, 23:55 II Oc. **16,** 403; 2:30 I Oc, 5:08 II EcR, 5:56 I EcR. **17,** 41032; 0:52 I Sh, 1:59 I TrE, 3:09 I ShE, 23:49 II ShE. **18,** 43201; 0:25 I EcR. **19,** 43210. **20,** 34012.

September 21, 13042; 4:00 III Oc, 5:28 IV Ec, 7:34 III OcR, 7:57 II Tr, 8:54 III Ec. **22,** 20134; 7:06 I Tr, 8:19 I Sh. **23,** 1034; 2:24 II Oc, 4:21 I Oc, 7:47 II EcR, 7:51 I EcR. **24,** 0324; 1:34 I Tr, 2:48 I Sh, 3:51 I TrE, 5:05 I ShE, 23:37 II Sh, 23:57 II TrE. **25,** 32014; 2:20 I EcR, 2:24 II ShE, 2:26 III ShE, 23:34 I ShE. **26,** 32104. **27,** 30124. **28,** 13024; 7:47 III Oc. **29,** 2013; 1:59 IV Tr, 6:07 IV TrE, 8:59 I Tr. **30,** 41203; 4:57 II Oc, 6:13 I Oc.

October 1, 40123; 3:27 I Tr, 4:44 I Sh, 5:43 I TrE, 7:00 I ShE, 23:42 II Tr. **2,** 430; 0:41 I Oc, 1:14 III TrE, 2:12 II Sh, 2:27 II TrE, 2:52 III Sh, 4:15 I EcR, 4:58 II ShE, 6:27 III ShE. **3,** 43210; 0:12 I TrE, 1:29 I ShE, 23:45 II EcR. **4,** 43021. **5,** 43102. **6,** 42013. **7,** 12403; 7:31 II Oc, 23:35 IV Ec. **8,** 0123; 4:04 IV EcR, 5:21 I Tr, 6:39 I Sh, 7:38 I TrE. **9,** 10324; 1:37 III Tr, 2:14 II Tr, 2:35 I Oc, 4:48 II Sh, 4:59 II TrE, 5:08 III TrE, 6:10 I EcR, 6:54 III Sh, 7:35 II ShE, 23:50 I Tr. **10,** 3204; 1:08 I Sh, 2:06 I TrE, 3:25 I ShE.

In the accompanying data, taken from the **American Ephemeris and Nautical Almanac,** following each date (in bold-face type) are given the telescopic satellite positions west (left) or east (right) of Jupiter (which is designated 0) at 2:30 UT in September, and at 1:15 in October.

Then are given the Universal time, the satellite (Roman number), and the phenomenon. Tr and TrE are the beginning and ending, respectively, of a satellite transit; Sh and ShE, same for the shadow; Ec and EcR are eclipse disappearance and reappearance, respectively; Oc and OcR, same for occultation.

VARIABLE STAR MAXIMA

September 2, Chi Cygni, 5.3, 194632; 8, RS Scorpii, 6.8, 164844; 18, X Centauri, 7.8, 114441; 18, RS Librae, 7.7, 151822; 21, RV Sagittarii, 7.8, 182133; 26, V Ophiuchi, 7.5, 162112; 30, RT Cygni, 7.4, 194048. October 3, U Herculis, 7.6, 162119; 7, R Normae, 7.2, 152849.

These predictions of variable star maxima are made by Leon Campbell, recorder of the AAVSO. Only stars are included whose mean maximum magnitudes, as recently deduced from a discussion of nearly 400 long-period variables, are brighter than magnitude 8.0. Some of these stars, but not all of them, are nearly as bright as maximum two or three weeks before and after the dates for maximum. The data given include, in order, the day of the month near which the maximum should occur, the star name, the predicted magnitude, and the star designation number, which gives the rough right ascension (first four figures) and declination (bold face if southern).

SKY-SCOPE

The new and improved 3½-inch Astronomical Telescope that amateurs everywhere are talking about.

Completely Assembled — Not a Kit
Equatorially Mounted, 60 Power
¼-wave Aluminized Mirror
Ramsden Type Ocular
Price $25.00 plus expressage

We invite your attention to our free brochure describing in a straightforward manner the instrument's amazing performance.

THE SKYSCOPE CO., INC.
475-s Fifth Avenue, New York 17, N. Y.

A 16" mirror and subdiameter tools.

LARGE-DIAMETER MIRRORS

Made to your order.

For further information, inquire

J. O. PAULSON, R. R. 3, Navarre, Ohio

EYEPIECE AND OBJECTIVE BARGAINS

Send for Free List

F. W. BALLANTYNE
P. O. Box 382
Point Pleasant New York

RAMSDEN EYEPIECES

$4.20 each

Professional Make — Excellent Optics

Brass mounts, 1¼" dia., easily cleaned, 1", ½", ¼" equivalent focal lengths

All guaranteed

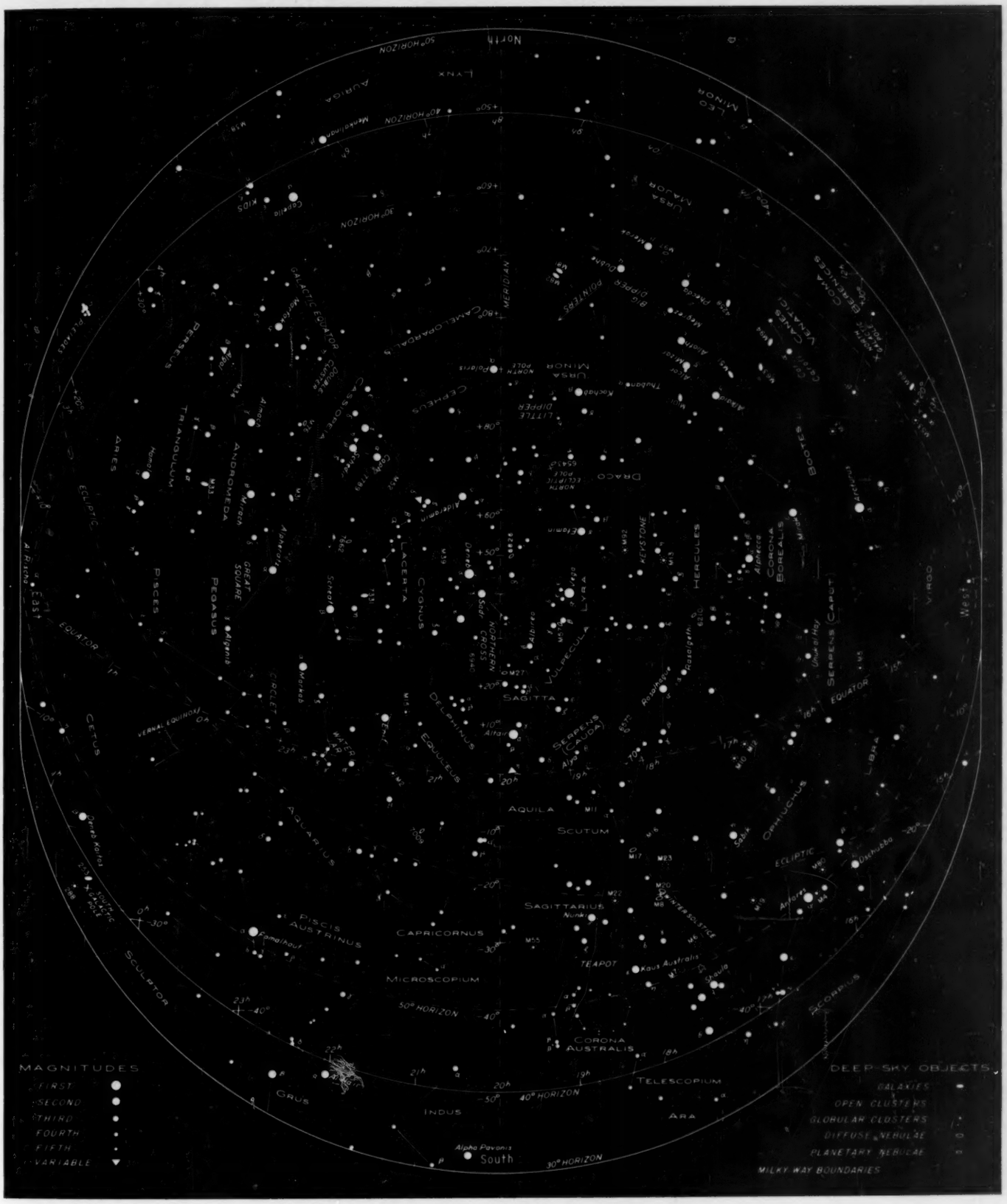
DE PALMA OPTICAL CO.
13031 Oxnard Blvd., Van Nuys, Calif.

Popular Size Refracting and Reflecting TELESCOPES

EQUATORIAL MOUNTINGS & ALL TELESCOPE PARTS

Price List Folder on Request

J. M. SCOPEMASTER
337 E. 81 St., New York 28, N. Y.



STARS FOR SEPTEMBER

BEFORE the Northern Crown sinks too far in the west, try to find its counterpart in the southern sky, Corona Australis. For observers near 40° north latitude, a good southern horizon will be necessary, but those living farther south should easily pick up this interesting circlet of 4th-, 5th-, and 6th-magnitude stars, located under the Teapot of Sagittarius. Nearby are Alpha and Beta Sagittarii, little known because so far removed from the other principal stars in the constellation.

A group of four of the smallest constellations in the sky is in good position for observing this month. Our chart shows only a few brightest stars in each, but with the aid of the **Atlas of the Heavens** or Norton's **Star Atlas** one should be able to pick out the stars in the areas comprising these groups. Start with Vulpecula, the Little Fox, underneath the Northern Cross in the Milky Way, and then find Sagitta, the Arrow; Delphinus, the Dolphin; and Equuleus, the Colt; each constellation is south or east of the preceding one.

Underneath the inverted peaked hat of Capricornus is another faint constellation, with a modern name, Microscopium. Far to the north on the same side of the meridian is Camelopardalis, the Giraffe.

Brilliant portions of the northern Milky Way are high in the sky this month.

SCHMIDT
TELESCOPE